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IDENTIFICATION AND SCREENING OF NEW REMEDIAL ALTERNATIVE 8B TECHNICAL MEMORANDUM NEW CASSEL GROUNDWATER CONTAMINATION SUPERFUND SITE TOWN OF HEMPSTEAD NASSAU COUNTY, NEW YORK

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1.0 INTRODUCTION

This Technical Memorandum (Tech Memo #1) for the New Cassel Industrial Area (NCIA) Superfund Site Operable Unit No. 1 (OU1) was prepared by Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc. (HDR) under the Army Corp of Engineers Kansas City District (USACE KC) Contract Number W912DQ-11-D-3007, Task Order Number 0009.

The New York State Department of Environmental Conservation (NYSDEC) issued a Record of Decision (ROD) for the NCIA Off-site Groundwater in October 2003. The ROD selected in-well vapor stripping with localized vapor treatment as the remedy to treat the contaminated groundwater. The ROD also provided for use of a contingency remedy using groundwater pump and treat, if pilot testing determined the selected remedy to be impractical due to engineering or economic reasons. In 2009 a pre-design investigation (PDI) was completed by Dvirka and Bartilucci Consulting Engineers (D&B). Results of the PDI determined the aquifer to be anisotropic and as a result D&B concluded that in-well air stripping would not be an effective technology for remediating the groundwater. NYSDEC then switched the remedial technology to the contingency remedy of extraction and treatment and a subsequent PDI for the contingency remedy was finalized in December 2011 by HDR. In March 2011 the United States Environmental Protection Agency (USEPA) proposed the New Cassel Hicksville Groundwater Contamination site to the National Priority List (NPL), which included the NYSDEC NCIA Off-site groundwater area (former OU-3). The Site was finalized to the NPL in September 2011.

EPA has designated the former NYSDEC off site area as OU-1. This Tech Memo #1 has been prepared to update the cost estimates in the *New Cassel Industrial Area Offsite Groundwater Remedial Investigation/Feasibility Study (RI/FS) Report, Volumes I, II and III*, prepared by Lawler Matusky and Skelly Engineers (LMS), dated September 2000. The FS update also includes the evaluation of an additional pump and treat alternative to address groundwater impacts across the entire aquifer. The additional remedy is included as Alternative 8B: Full Plume Remediation of Upper and Deep Portions of the Aquifer using Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection.

1.1 Purpose

The purpose of this Tech Memo #1 is to:

- Identify and complete a screening analysis for new Alternative 8B;
- Update the original cost estimates for each alternative included in the FS;
- Provide a cost estimate for new Alternative 8B; and

- Update the original comparative analysis to include Alternative 8B.

2.0 SITE DESCRIPTION AND HISTORY

2.1 Site Description

The NCIA is located in the Town of North Hempstead, Nassau County (Figure 2-1). It encompasses approximately 170 acres of land and is bounded to the north by the Long Island Rail Road; to the south by Old Country Road; and to the southwest by Grand Boulevard. The NCIA is a developed industrial and commercial area that has multiple sites listed on the New York State Registry of Inactive Hazardous Waste Sites. The EPA Operable Unit 1 consists of the off-site groundwater primarily located to the south of the NCIA (Figure 2-1).

Groundwater contamination plumes originating within the NCIA have migrated over 1,000 feet down gradient of the NCIA with contaminant concentrations greater than 1,000 parts per billion (ppb) of total chlorinated volatile organic compounds (CVOCs). Groundwater contamination has been detected within the OU1 area at depths greater than 200 feet below the existing ground surface. Contaminants have also impacted the Bowling Green public water supply wells installed in the Magothy aquifer located more than 500 feet below ground surface. Based on the previous on-site investigation data, there are three plumes (eastern, central and western) migrating from the NCIA across Old Country Road and into the off-site study area.

The USEPA assumed responsibility for the New Cassel Off-site Groundwater Contamination Site in September 2011 combined with the Hicksville Groundwater Contamination Site. A Hazard Ranking System Package was prepared in March 2011, with the Site scoring 50 of a possible 100 points. On March 10, 2011 the New Cassel/Hicksville Ground Water Contamination Superfund Site was proposed for placement on the NPL. The Site was placed on the NPL on September 16, 2011 (USEPA, 2011).

2.2 Geology and Hydrogeology

Directly underlying the study area is the Upper Glacial aquifer. The Upper Glacial aquifer is comprised of 60 to 80 feet of glacial outwash plain sediments consisting of relatively high permeability sand and gravel. Underlying the Upper Glacial aquifer is the Magothy aquifer and a distinct separation between the two aquifers is typically not found in this area as the aquifer material transitions from Pleistocene to Cretaceous. The Magothy aquifer is approximately 600 feet thick in the study area and is comprised of predominantly sand and silty sand with alternating low permeable laminated layers of silt and clay. Underlying the Magothy aquifer, in descending order, are the Raritan Clay confining unit, Lloyd aquifer and consolidated bedrock. Bedrock is approximately 1,000 feet below ground surface (bgs).

In the study area, groundwater is approximately 38 to 50 feet bgs. Regional groundwater flow in the Upper Glacial and Magothy aquifers is to the south and southwest.

3.0 SUMMARY OF REMEDIAL INVESTIGATIONS

3.1 Regulatory History and Previous Investigations

In 1986 the Nassau County Department of Health conducted a county wide groundwater investigation. The investigation identified widespread groundwater contamination throughout the NCIA. Following the investigation, in 1988 the NYSDEC listed the NCIA as a Class 2 site in the Registry of Inactive Hazardous Waste Disposal Sites in New York.

In order to identify the sources and responsible parties of contamination within the NCIA, the NYSDEC conducted Preliminary Site Assessments (PSAs) within the NCIA. Field investigations were conducted in fall 1994, fall 1995, and fall 1996. The NYSDEC also collected several soil and groundwater samples in December 1998, January 1999 and December 1999. Based on the findings of these PSAs, 17 sites were identified and listed as Class 2 sites in the Registry between May 1995 and September 1999. Of the 17 sites, three were investigated and delisted from the Registry, two sites were investigated, remediated and delisted from the registry, and one site was investigated, remediated and reclassified to a Class 4 site.

3.1.1 NYSDEC Remedial Investigations

NYSDEC conducted remedial investigations in the off-site area from 1995 to 2000. The activities conducted during the remedial investigations included:

- Installation of four shallow monitoring wells and fifteen hydro-punch locations down-gradient of the NCIA (summer 1996).
- Five rounds of groundwater monitoring well sampling. The first round (summer 1996) sampled 41 existing wells, including four new shallow wells
- The second round (summer 1997) sampled the same wells as the first round, and eleven hydro-punch locations south of Old Country Road.
- Early warning monitoring wells south of Old Country Road and up-gradient of the Bowling Green water supply wells were installed and sampled in July 1998.
- The third round (spring 1999) sampled 41 existing wells, and the four Bowling Green early warning wells. Four new wells were installed and sampled.
- The fourth round (summer 1999) sampled 41 existing groundwater monitoring wells, plus the four Bowling Green early warning monitoring wells.
- The fifth round (January 2000) sampled 22 existing monitoring wells and the four Bowling Green early warning monitoring wells.

Based on the results of these investigations NYSDEC determined that the off-site groundwater required remediating. A Feasibility Study (FS) was prepared to analyze eleven alternatives for remediating the groundwater. Alternatives evaluated in the FS included:

- Alternative 1: No Action
- Alternative 2: Long Term Monitoring
- Alternative 3: Monitored Natural Attenuation, Assessment and Contingent Remediation
- Alternative 4A: Remediation of Upper Portion of Aquifer (to 125 feet bgs) with In-Well Vapor Stripping/Localized Vapor Treatment
- Alternative 4B: Remediation of Upper Portion of Aquifer (to 125 feet bgs) with Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection
- Alternative 5A: Remediation of Upper and Deeper Portions of Aquifer (to 200 feet bgs) with In-Well Vapor Stripping/Localized Vapor Treatment
- Alternative 5B: Remediation of Upper and Deeper Portions of Aquifer (to 200 feet bgs) with Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection
- Alternative 6A: Full Plume Remediation of Upper Portion of Aquifer (to 125 feet bgs) with In-Well Vapor Stripping/Localized Vapor Treatment
- Alternative 6B: Full Plume Remediation of Upper Portion of Aquifer (to 125 feet bgs) with Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection
- Alternative 7A: Full Plume Remediation of Upper and Deeper Portions of Aquifer (to 200 feet bgs) with In-Well Vapor Stripping/Localized Vapor Treatment
- Alternative 7B: Full Plume Remediation of Upper and Deeper Portion of Aquifer (to 200 feet bgs) with Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection

The final RI/FS Report was completed in September 2000. Subsequent to finalizing the RI/FS, the NYSDEC issued a ROD for the site in October 2000. The ROD added and selected an additional remedy that was not included in the original FS. The remedy selected was listed as Alternative 8 (referred to as Alternative 8A in this Tech Memo), Full Plume Remediation of Upper and Deep Portions of the Aquifer (to 225 feet bgs) with In-Well Vapor Stripping/Localized Vapor Treatment. The ROD also allowed for a contingency remedy using ex-situ treatment and a centralized treatment building, if for engineering or economic reasons in-situ treatment proved to be impractical.

3.1.2 Pre-Design Investigations

Subsequent to NYSDEC issuing a ROD, two pre-design investigations were conducted for the off site area. The first was conducted in 2009 by Dvirka and Bartilucci Consulting Engineers (D&B) and the second by HDR in 2011.

The purpose for the first PDI was to verify the assumptions made during the FS for conceptual design of the in-well vapor stripping and provide details necessary for implementing the selected remedy. The investigation included groundwater quality assessment, geologic profiling and soil testing. The PDI activities included:

- Groundwater samples were collected from monitoring wells MW-1 through MW-9 and the Bowling Green early warning wells EW-1B, EW-2B, EW-1C, and EW-2C.
- Vertical profile groundwater sampling was conducted using two methods: temporary wells and hydro-punch sampling.
- Seven temporary wells were installed to approximately 285 feet below grade. A total of 85 groundwater samples were collected from the seven temporary wells.
- Two soil borings were constructed to a depth of 500 feet below grade. At each location, hydropunch groundwater samples were collected at 20-foot intervals from the water table (approximately 45 feet below grade) to the terminal depth of the boring at 500 feet below grade. A total of 48 groundwater samples were collected from the two hydropunch borings.
- Geological samples were collected from the two borings drilled to 500 feet below grade. Split spoon samples were collected and analyzed for particle size using America Society for Testing and Materials (ASTM) Method D422 and select samples were analyzed for vertical hydraulic conductivity using ASTM Method D5084 or D2434 (due to present of gravel).
- Six additional soil samples were collected from TMW-3D and five from TMW-8D.
- Gamma log readings were also used to identify potentially low permeability zones which could adversely impact recirculation patterns within the influence of the in-well air stripping wells.

D&B presented the following findings from the PDI:

- Based on literature data for the Magothy aquifer in the vicinity of the area of proposed treatment, anisotropies of approximately 100 or greater are not uncommon. Vertical hydraulic conductivity sampling revealed even higher degrees of anisotropy.
- Potentially significant low permeability zones exist within the Magothy aquifer in areas of proposed treatment.
- Local Town and County officials expressed concern during coordination efforts that the installation and operation of in-well air stripping units within public rights-of-way will be logistically difficult given the present of many utilities, including water, gas, electric, sanitary sewer, and storm sewer.
- Local Town and County officials offered to assist in the identification and use of potential public lands within the NCIA in order to locate a central treatment plant if conventional pump and treat remediation methods are chosen over in-well air stripping.

Results of the PDI completed by D&B indicated the Upper Glacial aquifer to be fairly isotropic, but the Magothy aquifer to be highly anisotropic. As a result D&B concluded that in-well air stripping would not be an effective technology for remediating the groundwater and recommended that the contingency remedy of ex-situ groundwater pump and treat be implemented in lieu of the in-well air stripping. D&B further recommended additional investigations since the vertical and horizontal extent of contamination had not been fully delineated.

NYSDEC then switched the remedial technology to the contingency remedy of extraction and treatment and a subsequent PDI to collect additional site specific data necessary to design the contingency remedy of ex-situ treatment was conducted by HDR in 2011. Activities completed in the second PDI included:

- Sampling of existing monitoring wells MW-1 through MW-9, the Frost Street monitoring wells FSMW-6B, FSMW-7B, and the FSMW-13 and FSMW-14 clusters, and the Bowling Green early warning wells EW-1B, EW-1C, EW-2B, and EW-2C;
- Installation and sampling of 11 new monitoring wells and two test extraction wells;
- 72-hour pump test of extraction well EX-1; and
- Pilot Test/Treatability Study for ex-situ treatment of contaminated groundwater using air stripping, carbon, and combined treatment using air stripping and carbon.

The PDI resulted provided a better understanding of the areal extent and depth of the contamination across the off-site area. The results indicated that the impacted area of groundwater was larger than previously assumed. The water level monitoring conducted as part of the pump test determined that the Bowling Green public water supply wells strongly influence the water levels in all of the Magothy aquifer wells that were monitored during the test. Results from the pump test showed the test extraction wells to be relatively high yielding wells and determined that a series of high yield pumping wells would be required to capture the known contamination. Results of the pilot test indicated that polishing using liquid phase carbon would be necessary to achieve the NYS groundwater quality standards and vapor phase treatment would be required for off-gas treatment. Based on concentrations of dissolved phase iron and other inorganics pretreatment would not be required. At the time the PDI was completed a suitable location for a centralized treatment building or reinjection location was not found and further investigation and negotiations with local officials would be necessary to secure a suitable location.

3.2 Nature and Extent of Contamination

The PDI conducted in 2011 resulted in a better understanding of the areal extent and depth of the contamination across the study area. The results indicated that the impacted area of groundwater is larger than previously believed. The currently known extent of the groundwater contamination

is shown on Figures 3-1 through 3-3. Consistent with the original FS there appears to be three separate plumes within the study area. The eastern plume is comprised predominantly of tetrachloroethylene (PCE) with some trichloroethylene (TCE) and very little 1,1,1-trichloroethane (TCA). The central plume consists of PCE, TCE and TCA. The western plume consists of TCE and PCE with minimal TCA. The contamination appears to migrate deeper as the distance along the plume axis increases away from the NCIA which is shown in the cross section cut along the Eastern Plume included as Figures 3-4 and 3-5.

In the eastern plume area, groundwater generally flows in a southern direction across the study area. In the central plume area, groundwater flows in a southwestern direction. In the western plume area, groundwater flows in a south-southwestern direction across the study area. There is a natural downward gradient across the study area that is enhanced by the almost continuous pumping at the Bowling Green Supply Wells (labeled as BG-1 and BG-2 on Figures 3-1 through 3-3).

The eastern plume is better defined in the northern section of the study area, although some additional delineation may be warranted. The eastern plume extends further to the south and deeper than detected in previous investigations based on the results from the 2011 PDI monitoring well pair MW-17. The location of MW-17 is down gradient of the Bowling Green Supply Wells indicating the contamination has migrated beyond the wells at a shallower depth than the basal water producing zone of the Magothy aquifer.

The central plume is orientated in a more southwest direction compared to the south-southwestern orientation of the western plume and south orientation of the eastern plume. This is consistent with the groundwater flow direction based on the groundwater elevation data collected during the PDI completed in 2011. The presence of TCA in the central plume can be used as a contaminant fingerprint to distinguish between the various plumes.

The 2011 PDI investigation was successful in delineating the plume to the west and south at the 200 feet depth. The western plume covers a larger areal extent compared to the eastern and central plumes which may indicate more than one source area (comingling plumes). Additional investigation would be needed to better define the western plume on the interior of the study area.

A review of the historical groundwater sampling results indicates that the contaminant plumes appear to be stable. There are localized areas where declining or increasing concentration trends are observed. These localized declining or increasing concentration trends can also be observed in the same monitoring well cluster location over various depths in the aquifer. The sampling data from the Early Warning Wells indicated that the concentration of CVOCs has decreased since the last sampling round in 2008 in both the deep and shallow wells. At this time only trace levels of CVOCs are found in the deep Early Warning Wells (EW-1C and EW-2C). However, when assessing all the available groundwater data as a whole, no significant concentration trends

were observed. The concentrations of PCE/TCE daughter compounds are relatively low to non-detect compared to the concentrations of PCE and TCE, indicating that biodegradation of PCE/TCE is not progressing at a significant rate within the study area.

4.0 DEVELOPMENT AND EVALUATION

The original FS identified eleven groundwater response alternatives. The original layouts for these alternatives have been included as Appendix A. Alternative 8A (formerly Alternative 8), which was added to the NYSDEC ROD consisted of in-well air stripping and localized vapor treatment to a depth of 225 feet bgs. In addition to adding Alternative 8 (now Alternative 8A), the ROD also included a contingency remedy of ex-situ groundwater treatment. This section provides a detailed description of the contingency remedy identified as Alternative 8B. Additionally this section will provide assumptions used in updating the cost estimates for the alternatives described in the original FS and Alternative 8A (former Alternative 8) discussed in the NYSDEC ROD. The updated assumptions are a result of additional investigations of the subsurface soils and updates in the technology of in-well air stripping which have occurred since the date of the original FS.

4.1 Development of Alternative 8B

Alternative 8B consists of a groundwater extraction system to capture contaminated groundwater from the shallow and deep aquifer, to depths of 280 feet below grade. The extracted groundwater will be pumped to one centralized treatment plant where groundwater will be treated using air stripping and liquid phase carbon to achieve effluent limits below the NYS groundwater quality standards. Treated effluent will then be re-injected back into the upper aquifer using drywells. This alternative assumes off-gas treatment using vapor phase carbon.

A conceptual layout showing the extraction well locations is shown on Figure 4-1 – Alternative 8B Groundwater Extraction/Air Stripping Full Treatment. Placement of the extraction wells target treatment of groundwater contaminated with levels of PCE and TCE in excess of 100 parts per billion (ppb) in the shallow (<175 feet below grade), intermediate (175-200 feet below grade) and deep (285 feet below grade) aquifers. Extraction wells were located centrally along each of the three plume lengths, increasing in depth as the plume moves south which corresponds with the downward migration of contamination. Shallow extraction wells will be installed to 150 feet below ground surface (bgs), intermediate to 200 feet bgs, and deep to 285 feet bgs. Additional extraction wells were placed down-gradient of the plume at the limit of the OU1 study area of the plume to provide hydraulic control.

Capture zones at different pumping rates were calculated using the aquifer characteristics determined during the 72 hour pump test completed during the 2011 PDI. Based on the results, calculated capture zones of 600 feet, 800 feet and 1,000 feet can be achieved at pumping rates of 50 gallon per minutes (gpm), 80 gpm and 100 gpm, respectively.

Capture of the 100 ppb CVOC contamination of the Eastern Plume, which is approximately 300 feet wide, will be achieved using four extraction wells consisting of one shallow, one

intermediate, and two deep, each pumping at 50 gpm. This will provide both mass removal and hydraulic control for this plume. The Central Plume 100 ppb CVOC contamination, also approximately 300 feet wide, will be captured using three extraction wells, one shallow, one intermediate and one deep, each pumping at 50 gpm. The Western Plume which is wider and not fully delineated to the east, will be captured using six extraction wells consisting of one shallow well pumping at 50 gpm, one intermediate well pumping at 80 gpm, and four deep extraction wells pumping at 100 gpm. In addition, one intermediate extraction well will be installed up-gradient of the Bowling Green water supply wells to capture low levels of PCE (<25 ppb) and TCE (<20 ppb) before reaching the water supply wells. The total peak flow rate from all extraction wells will be 930 gpm.

A suitable location for a centralized treatment plant has yet to be identified. For purposes of developing a cost estimate for this alternative, it was assumed that the centralized treatment plant would be located adjacent to the Bowling Green water supply wells in the vicinity of the Recharge Basin #51 parcel. This is the same location assumed to prepare cost estimates for the other alternatives in the FS. A 4,000 square foot (sf) building is estimated to house the treatment equipment and a small office for the full time operator. The groundwater treatment equipment will include a treatment system consisting of bag filters, a low-profile air stripper having six trays, two 20,000 lb liquid phase carbon vessels for polishing, and two 10,000 lb carbon vessels for off-gas treatment. Once treated, groundwater will be pumped into approximately 37 dry wells. Dry wells are assumed to have a diameter of 8 feet and a depth of 15 feet. The actual number of dry wells needed and locations will be determined during a pre-design investigation. For cost estimating purposes it is assumed that dry wells will be installed in the vicinity of Recharge Basin #51. For cost estimating, it was assumed that dry wells will be spaced a minimum of 50 feet apart and 10 feet from any structure. During the design the actual spacing and location will be evaluated to ensure recharged groundwater will not have an impact on the flow direction of the groundwater contamination.

This alternative will include institutional controls and long term monitoring. For costing purposes, it was assumed that the treatment system would run for 30 years in order to achieve the remedial action objectives for the site. Long term monitoring will be required during the entire 30 year period.

4.2 Development of Updated Cost Estimates

Cost estimates for the alternatives presented in the original FS which was prepared in 2000, were updated to account for inflation from 2000 to 2013. In addition to accounting for inflation, the cost estimates for alternatives providing active remediation were updated to include a cost for completing additional pre-design investigations needed to fully delineate the three plumes and complete a detailed design. Subsequent to completion of the original FS, additional PDI

activities were conducted providing field measurement of the aquifer characteristics and a revised nature and extent of contamination model. Based on this information, additional modifications to the cost estimates were made and are described in more detail in the following sections.

4.2.1 Alternatives 4B – 7B: Pump and Treat

The alternatives presented in the original FS assumed a combination of shallow, intermediate and deep extraction wells to provide contaminant mass removal and hydraulic control. The estimated capture zones were calculated based on published data for the aquifer. The capture zones shown for the pumping rates proposed were reviewed and compared to the aquifer data collected during the pump test completed as part of the 2011 PDI. The review determined that the original flow rates proposed for the alternatives would need to increase in order to achieve the capture zones shown on the layouts in the FS. The increase in overall flow rates required for each alternative to achieve the assumed capture zones shown in the FS are provided in Table 4-1.

To provide the updated cost estimates, the original configuration and number of extraction wells shown for each alternative was left unchanged. Instead, the cost was updated to reflect the overall increase in total flow as presented in Table 4-1. Increases in the flow rates affect the size of the treatment equipment needed to achieve the NYS groundwater quality standards, the number of dry wells needed for recharge, and the operation and frequency of maintenance required for the vapor phase carbon and bag filters, which were accounted for in the updated cost estimates.

4.2.1.1. Groundwater Treatment and Discharge

As assumed in the original estimates, groundwater treatment will occur in a centralized treatment building. The original cost estimates included pre-treatment using pH adjustment and coagulation/flocculation to remove inorganic constituents to prevent fouling of the air stripper. Based on the analytical results from the 2011 PDI, iron and total hardness concentrations are less than 1 mg/l and 40 mg/l, respectively and fouling of the air stripper is not anticipated. As a result, costs for the pre-treatment equipment were removed from all the alternatives.

The updated cost estimates include treatment equipment for removing total suspended solids using bag filters and VOCs using a low profile air stripper. To achieve the NYS Class GA groundwater standards, liquid phase granular activated carbon will be used as a polisher. Vapor emitted from the air stripper will be treated using granular activated carbon.

As assumed in the original estimates, treated groundwater will be re-injected using a series of dry wells having a diameter of 8 feet and depth of 15 feet. For estimating purposes, it was assumed that dry wells will be spaced a minimum of 50 feet apart and 10 feet from any structure. Calculations were completed to approximate the number of dry wells needed to manage the

treated groundwater. Based on calculations, 4 dry wells will be needed to effectively re-inject every 100 gpm of treated groundwater. During the pre-design investigation infiltration testing will be conducted to verify the number assumed in developing the cost estimates. For the updated cost estimates, the centralized treatment plant and dry wells are assumed to be located adjacent to the Bowling Green water supply wells, in the vicinity of the Basin #51 Parcel.

4.2.1.2. System Performance Monitoring

The original FS estimated time frames for active remediation based on the time it would take for the furthest contaminant with the highest retardation factor to be captured by the groundwater extraction system. The estimate was based on the retardation factor for PCE and a hydraulic conductivity of 70 feet / day. The FS assumed the following time frames for active remediation for each alternative.

- Alternative 4B: 9 years
- Alternative 5B: 12 years
- Alternative 6B: 7 years
- Alternative 7B: 10 years

The above time frames do not account for adsorption of the contaminants to soil particles and the release of adsorbed contaminants as contaminant mass is reduced in the groundwater. To account for this unknown, the active remediation for all the alternatives was increased to 30 years.

Performance monitoring for all alternatives to assess the effectiveness of the groundwater treatment system will be completed on a monthly basis. Groundwater samples will be collected at the influent, after the bag filters, between the carbon vessels, and at the effluent. Results will be used to determine the change out frequency for the bag filters and carbon. Carbon change out will consist of on site service to vacuum spent carbon from the vessels and replace it with reactivated carbon. Spent carbon will be sent off site to be either reactivated or disposed. Air samples will be collected monthly from the influent to the vapor phase carbon, between the carbon and at the stack.

The long-term monitoring program for all the alternatives is intended to assess the effectiveness of the groundwater extraction and treatment systems. For estimating purposes it was assumed that groundwater samples will be collected from all monitoring wells semi-annually for the first five years and then reduced to annually until the system is decommissioned after 30 years.

4.2.2 Alternatives 4A – 8A: In-Well Air Stripping

The alternatives presented in the original FS assumed a combination of shallow, intermediate and deep groundwater circulation wells to provide contaminant mass removal in the upper and

deeper portions of the aquifer. The original FS discusses the three main types of in-well vapor stripping systems, which include the Unterdruck-Verdampfer-Brunnen (UVB) or "vacuum vaporizer well" system, the NoVOCs™ system, and the Density Driven Convection (DDC) system. For purposes of cost estimating in the original FS, the UVB in-well vapor stripping system was assumed.

Each alternative was comprised of different combinations of wells installed at different depths to capture contamination at different zones of the aquifer. Different radiuses of influence were assumed in the original FS for stripping wells depending on depth. A summary of the well depths, pumping rates and associated radius of influence used in combination to make up each alternative is summarized in Table 4-2.

Based on the 2011 PDI data, a radius of influence of 125 feet at a pumping rate of 40 gpm was assumed for the updated FS. These wells were assumed to be spaced approximately 100 feet apart.

The decrease in the radius of influence relative to the original FS results in an increase in the total number of required stripping wells for each alternative. The number of required wells was calculated as the number of new ROI wells to match the diameter of the original FS ROI wells. For example, a striping well assumed to have a 200 foot ROI in the original FS was assumed to be replaced with two stripping wells, each with a 100 foot ROI. Table 4-3 summarizes the increase in the number of wells for each alternative.

Using the above assumption (100 foot well spacing), a layout for Alternative 8A was prepared as shown on Figure 4-2. The layout shows 77 in-well air stripping wells to cover the entire area of the three plumes. The layout places wells centrally along each plume to provide mass removal and perpendicular to groundwater flow along the OU1 study area limit of the plume of the plume to provide containment treatment of the plume.

4.2.2.1. Vapor Treatment

The original FS assumed localized vapor treatment using granular activated carbon contained in vaults at the wellhead. The increase in the number of groundwater stripping wells makes localized vapor treatment at each wellhead more difficult to implement and less cost effective relative to a centralized treatment system. The vault size to contain all the equipment needed for stripping and vapor treatment is estimated to be roughly 75 square feet and individual purchases for treatment equipment for each well increases the cost considerably. Therefore, a centralized treatment system was assumed to prepare the cost estimates for all the in-well air stripping alternatives for the updated FS.

The centralized treatment building is assumed to be located adjacent to the Bowling Green water supply wells. The building will be approximately 800 square feet and will house two 10,000 lb granular activated carbon vessels, ancillary equipment, and a small office for the operator. Based on data form the 2011 pilot study and estimated flow rates, it is assumed that both vapor phase carbon vessels will need to be changed out once per year.

4.2.2.2. System Performance Monitoring

The original FS estimated time frames for active remediation based on discussion with vendors and review of case studies. The original FS assumed the following time frames for active remediation for each alternative.

- Alternative 4A: 7 years
- Alternative 5A: 9 years
- Alternative 6A: 5 years
- Alternative 7A: 7 years
- Alternative 8A: 7 years

As mentioned in the FS many parameters used in deriving estimated active remediation time frames can vary and significantly change the required remediation time. To account for these unknowns, the active remediation time period for all the alternatives was increased to 30 years.

Performance monitoring will be completed for all alternatives to assess the effectiveness of the in-well vapor treatment system. Sample results will be used to verify the treatment efficiency of the in-well air strippers. Monthly air samples will also be collected at the influent, between the carbon vessels, and at the effluent of the vapor treatment system. Samples of collected condensate will be collected as required prior to disposal or discharge to the Public Owned Treatment Works (POTW). Results of performance samples will be used to determine the change out frequency for the carbon, cleaning frequency for the in-well air strippers and compliance with regulatory permits. Carbon change out will consist of an on site service to vacuum spent carbon from the vessels and replace it with reactivated carbon. Spent carbon will be sent off site to be reactivated or disposed.

The long-term monitoring program for all the alternatives is intended to assess the effectiveness of the groundwater in-well vapor stripping systems. For estimating purposes it was assumed that groundwater samples will be collected from all monitoring wells semi-annually for the first five years and then reduced to annually until the system is decommissioned after 30 years. The actual time frame for monitoring can be re-evaluated and possibly reduced or discontinued at any time during the project time frames.

5.0 DETAILED EVALUATION OF ALTERNATIVES

5.1 Introduction

This section provides an individual analysis of Alternative 8B and an updated comparative analysis for the original FS to include Alternative 8B. The purpose of the evaluation is to identify the advantages and disadvantages of each alternative as well as key trade-offs among the alternatives. The detailed evaluation of Alternative 8B consists of an individual analysis against the evaluation criteria and a comparative analysis among the alternatives to assess the relative performance of each alternative with respect to the evaluation criteria.

The evaluation was based on criteria established under *Interim Final Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (EPA October 1988). The nine evaluation criteria have been developed to address Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) requirements and to address the additional technical and policy considerations that have proven to be important for selecting among remedial alternatives. The evaluation criteria are as follows:

- **Overall Protective of Human Health and the Environment:** This criterion is an evaluation of the alternative's ability to protect public health and the environment, assessing how risks posed through each existing or potential pathway of exposure are eliminated, reduced or controlled through removal, treatment, engineering controls or institutional controls. The alternative's ability to achieve each of the remedial action objectives (RAOs) is evaluated.
- **Compliance with Applicable or Relevant and Appropriate Requirements (ARARs):** This criterion evaluates how the alternative complies with the ARARs, or if a waiver is required and how it is justified.
- **Long Term Effectiveness and Permanence:** Each alternative is evaluated for its long-term effectiveness after implementation. If wastes or treated residuals remain on-Site after the selected remedy has been implemented, the following items are evaluated:
    - The magnitude of the remaining risks (i.e., will there be any significant threats, exposure pathways, or risks to the community and environment from the remaining wastes or treated residuals);
    - The adequacy of the engineering and institutional controls intended to limit the risk;
    - The reliability of these controls, and
    - The ability of the remedy to continue to meet RAOs in the future.

- **Reduction of Toxicity, Mobility, or Volume:** The alternative's ability to reduce the toxicity, mobility or volume of Site contamination is evaluated. Preference should be given to remedies that permanently and significantly reduce the toxicity, mobility, or volume of the wastes at the Site.
- **Short Term Effectiveness:** The potential short-term adverse impacts and risks of the remedy upon the community, the workers, and the environment during the construction and/or implementation are evaluated. A discussion of how the identified potential adverse impacts to the community or workers at the Site will be controlled, and the effectiveness of the controls, should be presented. A discussion of engineering controls that will be used to mitigate short term impacts (i.e., dust control measures) is provided. The length of time needed to achieve the remedial objectives is also estimated.
- **Implementability:** The technical and administrative feasibility of implementing each alternative is evaluated for this criterion. Technical feasibility includes the difficulties associated with the construction and the ability to monitor the effectiveness of the remedy. For administrative feasibility, the availability of the necessary personnel and material is evaluated along with potential difficulties in obtaining specific operating approvals, access for construction, etc.
- **Relative Cost:** This criterion evaluates the estimated capital, operations, maintenance, and monitoring costs for each alternative. Relative costs are estimated and presented on a present worth basis.
- **State Acceptance:** The public's comments, concerns and overall perception of the remedy are evaluated in a format that responds to all questions that are raised (i.e., responsiveness summary).
- **Community Acceptance:** The public's comments, concerns and overall perception of the remedy are evaluated in a format that responds to all questions that are raised (i.e., responsiveness summary).

The eighth and ninth criteria, State and Community acceptance, will be evaluated following public comments on the updates to the FS and will be addressed once a final decision has been made and the Record of Decision (ROD) is being prepared.

The individual analyses for Alternatives 1 through 8 are provided in the NYSDEC ROD and are summarized in Table 5-1.

5.2 Individual Analysis of Alternative 8B

This section presents the individual analysis for Alternative 8B with respect to the first seven criteria:

Overall Protection of Human Health and the Environment – Alternative 8B provides overall protection of human health and the environment by removing contaminant mass from the

shallow and deep aquifers and providing hydraulic control of the plume within OU1 to prevent further migration. Treatment for removal of VOCs from the Bowling Green water supply wells will continue to be in operation during this time, which will eliminate exposure to contaminants through ingestion by requiring treatment of groundwater before use as a water supply source. Additional protection is provided by the institutional controls that reduce the risk of ingestion of contaminated groundwater.

Compliance with ARARs – Alternative 8B will meet the ARARs after an extended period of operation. The treatment system will be designed to address groundwater with contaminant concentrations greater than the NYSDEC Class GA groundwater quality standards.

There are no promulgated air quality standards for the COCs in the off-site groundwater under the National Ambient Air Quality Standards (NAAQS) or the NY Ambient Air Quality Standards (NYAAQS). However, emissions from the groundwater treatment plant will comply with the requirements of NYSDEC Air Toxics Program promulgated at Title 6 of the New York State Code of Rules and Regulations (6NYCRR) Part 212 and the corresponding guidance values in NYSDEC's guidance document *Guidelines for the Control of Toxic Ambient Air Contaminants*, which provides NYSDEC's policy for the control of toxic ambient air contaminant sources not directly addressed by the NYS or federal ambient air quality standards.

Long Term Effectiveness and Permanence – Alternative 8B will reduce and permanently remove VOCs from the groundwater over an extended period of time. The time frame estimated for Alternative 8B to meet the RAOs is a minimum of 30 years. Treatment for removal of CVOCs from the Bowling Green water supply wells will continue to be in operation during this time, which will eliminate exposure to contaminants through ingestion. Institutional controls will eliminate the potential for ingestion of contaminated groundwater by prohibiting its use as a water supply without treatment. A long-term monitoring program will be implemented to verify the long term effectiveness of the groundwater extraction and treatment system. In accordance with CERCLA, a review will need to be conducted at least once every 5 years to verify that the remedy continues to provide adequate protection of human health and the environment.

Reduction of Toxicity, Mobility, or Volume of Contamination through Treatment – Alternative 8B will reduce the toxicity and volume of contamination from the groundwater by removing contaminant mass from the aquifer. Air stripping will transfer CVOCs to the vapor phase which will then be treated using granular activated carbon. CVOCs adsorbed to the carbon will be destroyed during the carbon reactivation process.

Short Term Impacts and Effectiveness – The installation of extraction wells, transmission piping and the treatment plant building are expected to result in minimal impacts to human health or the environment. Potential exposure to contaminants will be minimal because contaminants are

located in the subsurface groundwater. Dust control measures may be necessary during installation of the transmission piping and treatment plant building, which will require the largest area of disturbance. Installation of the transmission piping and extraction wells will have an impact on traffic, because they will be installed along local roads in the off-site area. During installation traffic may need to be re-routed around roads where structures will be installed and additional personnel will be needed to provide traffic control. Construction will temporarily increase noise during work hours in the residential neighborhoods where extraction wells and transmission piping will be installed.

Implementability – The technologies required for installing extraction and dry wells and constructing the groundwater treatment system are readily available. The technology proposed for vapor treatment is a commonly applied technology that is readily implementable.

A suitable location for the centralized treatment plant has yet to be identified. A review of all the properties within a quarter mile radius of the off-site study area to identify potential sites was completed. Using the Nassau County Department of Assessment GIS land record viewer and the Long Island Index interactive map, eight (8) publically owned and 29 commercial/community service properties were identified. Five of the public properties were screened out (two were schools and three appeared to be foreclosed residences and were too small). The remaining public properties included the Bowling Green public water supply properties, storm water recharge Basin 51, and water supply well/basin. Due to the size of the property and the restricted access, the water supply well/basin does not appear to be a viable location for the treatment plant. Based on the preliminary screening Recharge Basin 51 or the Bowling Green Water District properties are the only viable locations within a quarter mile of the study area. Further investigations will need to be conducted to identify a suitable location.

Re-injection of the full amount of treated groundwater will require the installation of 30 dry wells. The area required for installation of the number of dry wells needed is estimated to be 75,000 square feet. A suitable location that will be acceptable to the community will need to be identified for the installation of the dry wells.

Relative Cost – The 30-year present value cost of this alternative is estimated to be $24.9 million. The capital cost is estimated to be $8,698,000 and the average annual operations and monitoring cost is estimated to be $1,546,000. The capital cost is primarily for construction of the extraction wells, transmission piping, centralized treatment building and treatment equipment. The operations and monitoring costs include monitoring and maintenance the extraction wells, transmission piping and treatment system equipment. The estimated cost for Alternative 8B is summarized in Table 5-2.

5.3 Updated Cost Analysis of Alternatives

The cost estimates for the alternatives presented in the original FS were updated to account for inflation from 2000 to 2013. In addition to accounting for inflation, the cost estimates for the alternatives were also updated to reflect modifications to the assumptions used in the original FS based on information obtained during subsequent PDIs. The cost estimate revisions included:

- Increased estimated flow rates based on aquifer pump tests;
- Reduction in in-well air stripping ROI resulting in increase number of stripping wells;
- Increased estimated remedial time frames; and,
- Increase vertical and horizontal extent of groundwater contamination footprint.

The estimated costs for Alternatives 1 through 8A are summarized in Tables 5-3 through 5-14.

5.4 Updated Comparative Analysis of Alternatives

A comparative analysis was completed where the alternatives were evaluated in relation to each other for each of the evaluation criteria. The purpose of this analysis is to identify the relative advantages and disadvantages of each alternative.

5.4.1 Overall Protection of Human Health and the Environment

All the alternatives include institutional controls and the continued operation of the VOC treatment system for the Bowling Green water supply wells which provide protection of human health by preventing ingestion of contaminated groundwater. Alternatives 1, 2 and 3 provide the least protection of human health and no protection for the environment when compared with the other alternatives since these alternatives will not reduce contamination levels or prevent the migration of the contaminant plumes.

Of the active treatment remedies, Alternatives 4A and 4B (remediation of "hot spot" areas in the upper portion of the aquifers) provide similar levels of protection in that they each reduce levels of contaminants of concern (COCs) in off-site groundwater to a depth of 125 feet bgs and control further down-gradient migration of VOCs. Alternatives 4A and 4B also rely on natural attenuation to achieve remedial objectives for the groundwater contamination. Likewise, Alternatives 5A and 5B provide similar levels of protection to one another (i.e., remediation of "hot spot" areas in upper and deep portions of the off-site groundwater contamination, to a depth of 200 feet bgs). Alternatives 6A and 6B address groundwater contamination in the upper portion of the aquifer so that NYS Class GA standards are met. Alternatives 7A and 7B also achieve Class GA standards through active remediation, but target the upper and deep portions (to 200 feet bgs) of the aquifer. Alternatives 8A and 8B also achieve Class GA standards through active remediation but target the upper and deep portions of the aquifer to a depth of 285 feet bgs which is the current known

vertical extent of the contamination. Alternative 8A or 8B provide the greatest protection of human health and the environment, as Class GA standards are achieved for the entire aquifer to a depth of 285 feet bgs. Alternative 4 through 7 do not address all of the contamination in the aquifer and rely on natural attenuation to achieve the RAOs.

5.4.2 Compliance with ARARs

Alternative 1 does not comply with any ARARs with the exception of the Federal and state requirement to include a "no action" alternative in the range of detailed evaluation. Alternatives 2 and 3 will not quickly or actively achieve site ARARs.

All active remediation alternatives will comply with the ARARs for both groundwater and air emissions. Alternatives 6A, 6B, 7A, 7B, 8A and 8B are expected to be more effective at meeting the RAOs since these alternatives will treat both the upper and deep portions of the aquifer and will remove more contamination than the Alternatives 4A, 4B, 5A, and 5B which will treat only a portion of the aquifer and will leave a larger portion of the aquifer untreated. Alternatives 8A and 8B will have the highest mass removal than all the alternatives as these alternatives will address the deepest portion of the aquifer determined to be impacted.

5.4.3 Long Term Effectiveness and Permanence

Alternatives 1, 2 and 3 do not provide high degrees of long-term effectiveness or permanence as no active remediation measures are proposed. Alternative 2 and 3 rely on natural attenuation to reduce VOC groundwater contamination and will likely have limited effectiveness given the lack of CVOC daughter compounds in the aquifer suggesting minimal if any biological degradation is occurring.

Alternatives 4A, 4B, 5A, and 5B permanently remove VOC contaminants from the groundwater through active extraction and treatment processes. For these alternatives “hot spot” areas of groundwater contamination are addressed and natural attenuation is relied upon to help achieve RAOs. Alternatives 6A, 6B, 7A, 7B, 8A and 8B also permanently remove VOC contaminants from groundwater through active extraction and treatment processes. The areal extent of off-site groundwater contamination is addressed with active treatment in these scenarios, and Class GA standards are achieved to the depths designated for each Alternative. Implementation of Alternatives 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, or 8B (all active remedies) is expected to provide a degree of long-term effectiveness and permanence, with implementation of Alternative 8A or 8B (remediation of upper and deep portions of the aquifer to Class GA standards with active treatment) expected to provide the highest degree of long-term effectiveness and permanence since these alternatives will treat the entire aquifer.

The estimated timeframes for operating the in-well vapor stripping and pump and treat systems for all the alternatives presented is conservatively estimated to be 30 years.

5.4.4 Reduction of Toxicity, Mobility, or Volume

Alternatives 1, 2, and 3 will allow natural processes to dissipate the contaminants, but will not create any reduction of toxicity, mobility, or volume of contamination present in the off-site groundwater, as no active remedial measures are included.

Alternatives 4A, 4B, 5A, and 5B would result in a permanent decrease in the concentration, mobility, and volume of contaminants present in the aquifer. These alternatives address "hot spot" areas with removal or active treatment. Alternatives 6A, 6B, 7A, 7B, 8A and 8B would result in a permanent decrease in the concentration, mobility, and volume of contaminants present in the aquifer. Contaminants under Alternative 4 through 8 would be treated or removed and treated via air stripping transferring the contamination to the vapor phase. Vapor phase contaminates would be treated via adsorption onto GAC and ultimately destroyed during the carbon reactivation process.

For the in-well vapor stripping and pump and treat scenarios, reductions in toxicity, mobility, and volume of VOCs would be the greatest under Alternatives 8A and 8B where the entire aquifer within OU1 is targeted (i.e., treatment of the off-site groundwater contaminants to depths of 285 feet bgs).

5.4.5 Short Term Impacts and Effectiveness

Alternatives 1, 2, and 3 result in the least amount of short-term impacts to human health and the environment as the only site activities included (in Alternatives 2 and 3) are monitoring well installation and sampling.

Alternatives 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A and 8B would cause short-term disruptions to the surrounding community due to construction of the remedial components. Alternatives 4A, 5A, 6A, 7A and 8A would cause more disruption to the community than the corresponding pump and treat alternatives since the number of wells required for the in-well vapor treatment system as compared to the pump and treat system is two to five times more wells. Additional trenching would also be required for the in-well vapor stripping alternatives if a centralized vapor treatment system is used.

Alternatives 4A, 4B, 6A, and 6B are considered to have less short-term impacts than Alternatives 5A, 5B, 7A, 7B, 8A and 8B, because these alternatives require less supporting infrastructure.

The potential hazards to workers implementing the remedy and the surrounding public due to implementation of these alternatives is expected to be minor for the active treatment alternatives. Some noise and traffic would be expected during the brief period of construction of Alternatives 4A, 4B, 5A, 5B, 6A, 6B, 7A, 7B, 8A, and 8B with the least amount of disruption anticipated under Alternatives 4A and 4B and the most disruption under Alternatives 8A and 8B.

5.4.6 Implementability

All thirteen alternatives are readily implementable. Alternative 1 is the easiest of the alternatives to implement (No Further Action). Alternative 2 involves monitoring well installation, a site characterization program, establishment of institutional measures, and long-term MNA monitoring. Alternative 3 is also straightforward, as only the construction of monitoring wells, establishment of institutional measures, and a long-term monitoring program are required.

Alternatives 4A, 5A, 6A, 7A, and 8A involve the installation of in-well vapor stripping wells and a centralized vapor treatment system building. The in-well vapor stripping technology is patented to a small number of vendors. Treatment wells and vaults can be located in streets or rights-of-way, which will require little or no land acquisition. Coordination with the local Department of Public Works and subsurface investigation to adequately locate underground utilities will be required to identify suitable locations for these vaults. Assuming larger vaults (>75 square feet needed to provide vapor treatment) will not be accepted or suitably fit into existing local roads and right of ways, it was assumed that a small centralized vapor treatment plant will be used to treat vapors from the in-well air strippers. A suitable location and land acquisition for the small treatment plant will need to be identified prior to implementing these alternatives.

Alternatives 4B, 5B, 6B, 7B, and 8B include the installation of a groundwater extraction and treatment system, which is a commonly applied technology at inactive hazardous waste sites. Under each of these five pump and treat scenarios, land would need to be acquired for the installation of a central treatment building (3,200 - 4,000 square feet) and wet wells for effluent re-injection.

5.4.7 Relative Cost

The costs of each remedial alternative are summarized in Table 5-1. Alternative 1, which includes implementation of institutional controls has the lowest present value cost of $71,000. Alternatives 3 and 2 which are long term monitoring and natural monitored attenuation have the next lowest costs of $2.8 million and $3.5 million, respectively.

Alternative 4A (remediation of upper portion of aquifer [to 125 feet bgs] with in-well vapor stripping) has an estimated present worth cost of $14.2 million. Alternative 5A (remediation of upper and deep portions of aquifer [to 200 feet bgs] with in-well vapor stripping) was found to have the fifth lowest estimated present worth cost $14.8 million). Alternative 4B (remediation of

upper portion of the aquifer [to 125 feet bgs], $15.7 million and Alternative 5B (remediation of upper portion and deep portions of the aquifer [to 200 feet bgs], $15.9 million were found to have the sixth and seventh lowest estimated present worth cost. Alternative 6A (full plume remediation of upper portion of aquifer [to 125 feet bgs] with in-well vapor stripping, $19.2 million), and Alternative 7A (full plume remediation of upper and deep portions of aquifer [to 200 feet bgs] with in-well vapor stripping, $22.7 million) had the eighth and ninth lowest present worth costs followed by Alternative 6B (full plume remediation of upper portion of aquifer [to 125 feet bgs]), $23.0 million, Alternative 8A (full plume remediation of upper portion and deep portions of the aquifer), $23.1 million and Alternative 8B (full plume remediation of upper and deep portion of aquifer with groundwater extraction/air stripping), $24.9 million.

For each active treatment technology, the systems that address the upper and deep portions of the aquifer were found to be more costly than the corresponding systems that address only the upper portion of the aquifer. An analysis of the two active treatment technologies conducted for this FS found that for in-well vapor stripping, the local treatment alternatives were typically less expensive than the comparative central treatment alternatives.

Individual alternative cost tables for the active remedies are included in Tables 5-2 through 5-14.

6.0 REFERENCES

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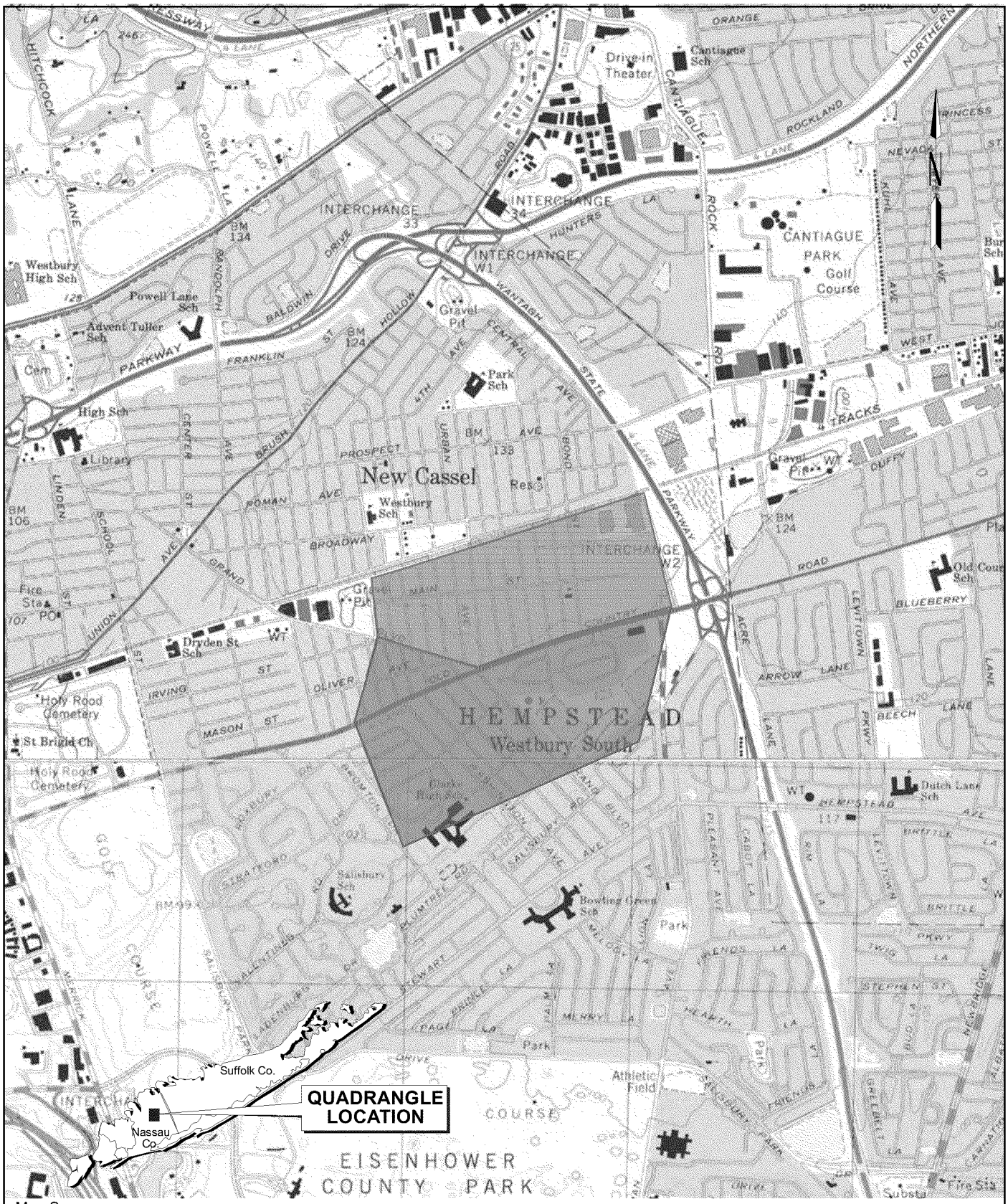
7.0 GLOSSARY OF ACRONYMS AND ABBREVIATIONS

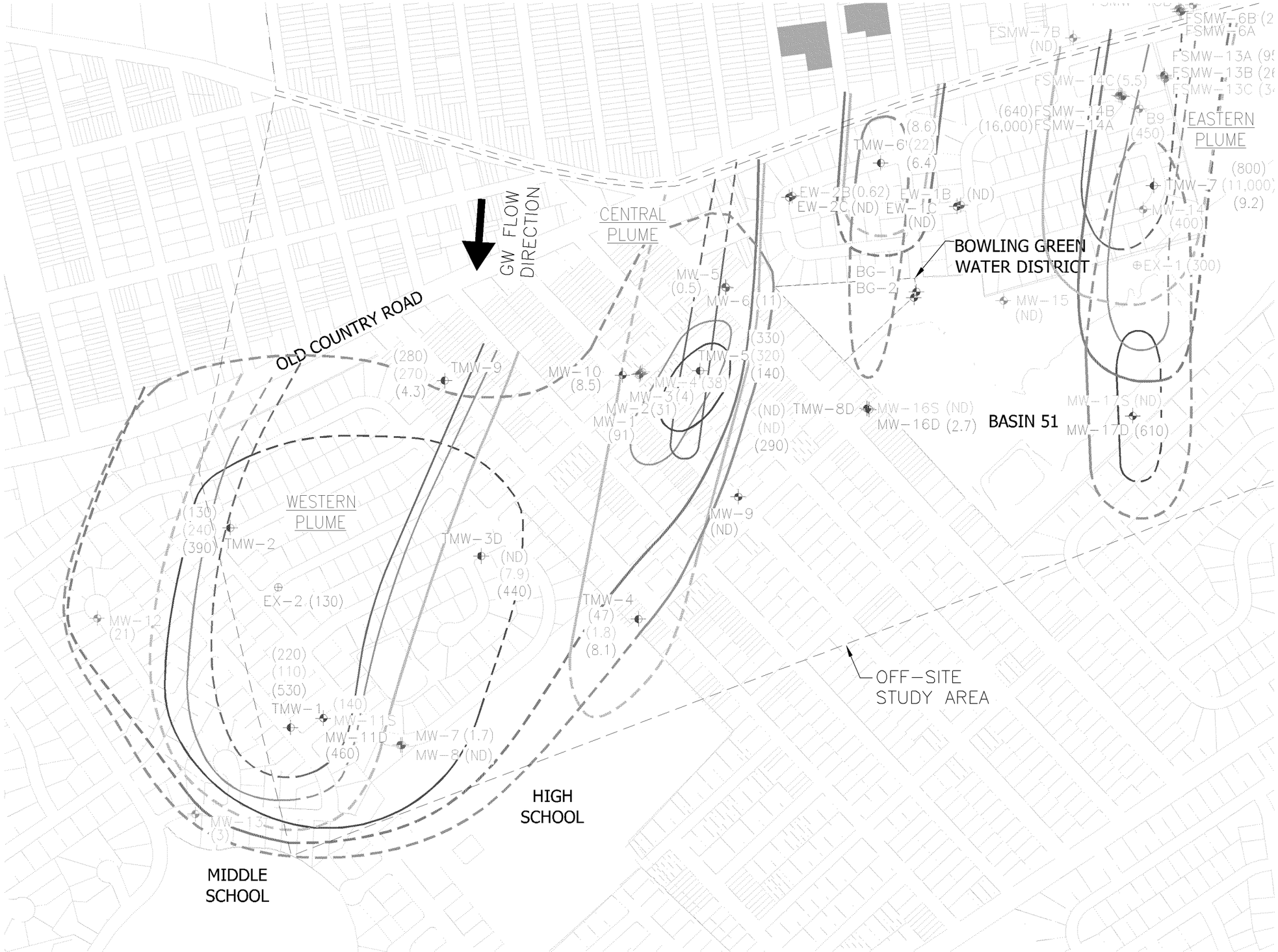
ARAR	Applicable or Relevant and Appropriate Requirement
AST	aboveground storage tank
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene, xylene
CAMP	Community Air Monitoring Program
C&D	construction and demolition
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm/sec	centimeters per second
CPP	Community Participation Plan
CVOC	chlorinated volatile organic compound
DCE	Dichloroethene
DER	Data Evaluation Report
DNAPL	dense non-aqueous phase liquid
DP	direct push
DPE	Dual phase extraction
DQO	Data Quality Objective
EPA	United States Environmental Protection Agency
ft/day	foot per day
ft^2/day	feet squared per day
FS	Feasibility Study
GAC	granular activated carbon
gpm	gallons per minute
gpm/ft	gallons per minute per foot
GRA	General Response Action
H_2S	hydrogen sulfide
HDR	Henningson, Durham & Richardson Architecture and Engineering, P.C. in association with HDR Engineering, Inc.
IA	Integrated Assessment
IRM	Interim Remedial Measures
ISCO	In-situ Chemical Oxidation
K	hydraulic conductivity
LNAPL	light non-aqueous phase liquids
LTM	Long Term Monitoring
mg/kg	milligrams per kilogram
mg/l	milligrams per liter
mgd	million gallons per day
MW	monitoring well
NAPL	Non-Aqueous Phase Liquid
NPL	National Priorities List
NYCRR	New York Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
ORC	oxygen releasing compound
OSHA	Occupational Health and Safety Administration

PCE	tetrachloroethylene
POTW	Publicly Owned Treatment Works
PRB	permeable reactive barrier
PSA	Preliminary Site Assessment
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
ROD	Record of Decision
SG	soil gas
SPDES	State Pollutant Discharge Elimination System
SVE	soil vapor extraction
SVOC	semi-volatile organic compound
T	transmissivity
TCLP	Toxic Characteristic Leaching Procedure
TOGS	Technical & Operational Guidance Series
TP	test pit
TSCA	Toxic Substance Control Act
ug/l	micrograms per liter
ug/m^3	micrograms per cubic meter
UGA	Upper Glacial Aquifer
UV	ultraviolet
VC	vinyl chloride
VOC	volatile organic compound

Figures



HDR	Henningson, Durham & Richardson Architecture and Engineering, P.C. One Blue Hill Plaza Pearl River, NY 10965	**Site Location Map**	**Figure** 2-1



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LEGEND:

- TMW-7 — TEMPORARY MONITORING WELL LOCATION
- MW-5 — MONITORING WELL LOCATION
- LIMIT OF OFF-SITE STUDY AREA
- LIMIT OF NEW CASSEL INDUSTRIAL AREA
- SOURCE AREA PROPERTIES
- BGS — BELOW GROUND SURFACE
- PPB — PART PER BILLION
- ug/l — MICROGRAMS PER LITER
- PCE — TETRACHLOROETHENE
- < 175 FEET BGS
- 175 – 250 FEET BGS
- > 250 FEET BGS
- 100 PPB (ug/l) PCE ISO CONCENTRATION CENTER AT 150 FEET BGS (DASHED WHERE INFERRED)
- 100 PPB (ug/l) PCE ISO CONCENTRATION CENTER AT 200 FEET BGS (DASHED WHERE INFERRED)
- 100 PPB (ug/l) PCE ISO CONCENTRATION CENTER AT 285 FEET BGS (DASHED WHERE INFERRED)
- (800) PCE CONCENTRATION AT 150 FEET BGS
- (11,000) PCE CONCENTRATION AT 200 FEET BGS
- (9.2) PCE CONCENTRATION AT 285 FEET BGS
- 5 PPB PCE ISO CONCENTRATION CENTER AT 150 FT BGS (DASHED WHERE INFERRED)
- 5 PPB PCE ISO CONCENTRATION CENTER AT 200 FT BGS (DASHED WHERE INFERRED)
- 5 PPB PCE ISO CONCENTRATION CENTER AT 285 FT BGS (DASHED WHERE INFERRED)

NOTES:

1. FIGURE DEPICTS MONITORING WELLS LOCATED WITHIN THE EPA OU-1 AREA SOUTH OF OLD COUNTRY ROAD. NUMEROUS EXISTING MONITORING WELLS ARE FOUND NORTH OF OLD COUNTRY ROAD WITHIN INDUSTRIAL AREA THAT ARE NOT SHOWN.
2. TMW-1, 2, 4, 5, 6, 7, AND 9 WERE SAMPLED AT MULTIPLE DEPTHS FROM GROUNDWATER SURFACE TO A TOTAL DEPTH OF 285 FEET BELOW GROUND SURFACE.
3. TMW-3D AND 8D WERE SAMPLED AT MULTIPLE DEPTHS FROM GROUNDWATER SURFACE TO A TOTAL DEPTH OF 502 FEET BELOW GROUND SURFACE.

GRAPHIC SCALE

200 0 200 400

(IN FEET)

1 inch = 200 ft.

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HDR

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

PCE ISO-CONCENTRATION MAP

Sheet Reference Number:

3-1

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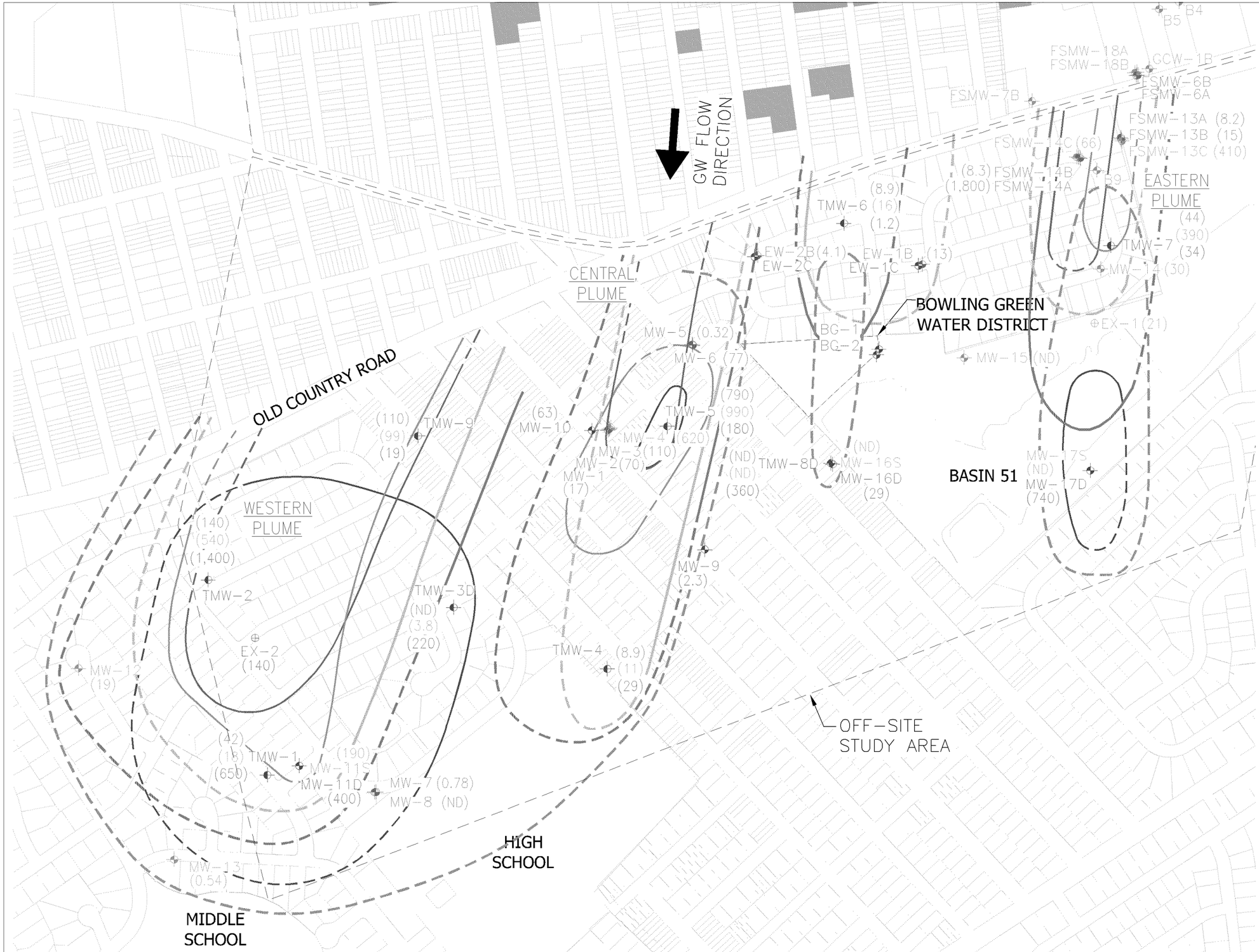

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- (800) — TCE CONCENTRATION AT 150 FEET BGS
- (11,000) — TCE CONCENTRATION AT 200 FEET BGS
- (9.2) — TCE CONCENTRATION AT 285 FEET BGS
- —70— GROUNDWATER CONTOUR ABOVE MEAN SEA LEVEL
- 5 PPB TCE ISO CONCENTRATION CENTER AT 150 FT BGS (DASHED WHERE INFERRED)
- 5 PPB TCE ISO CONCENTRATION CENTER AT 200 FT BGS (DASHED WHERE INFERRED)
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GRAPHIC SCALE

200 0 200 400

(IN FEET)

1 inch = 200 ft.

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Submitted by: TC | CADD File Name:

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

TCE ISO-CONCENTRATION MAP

Sheet Reference Number: 3-2

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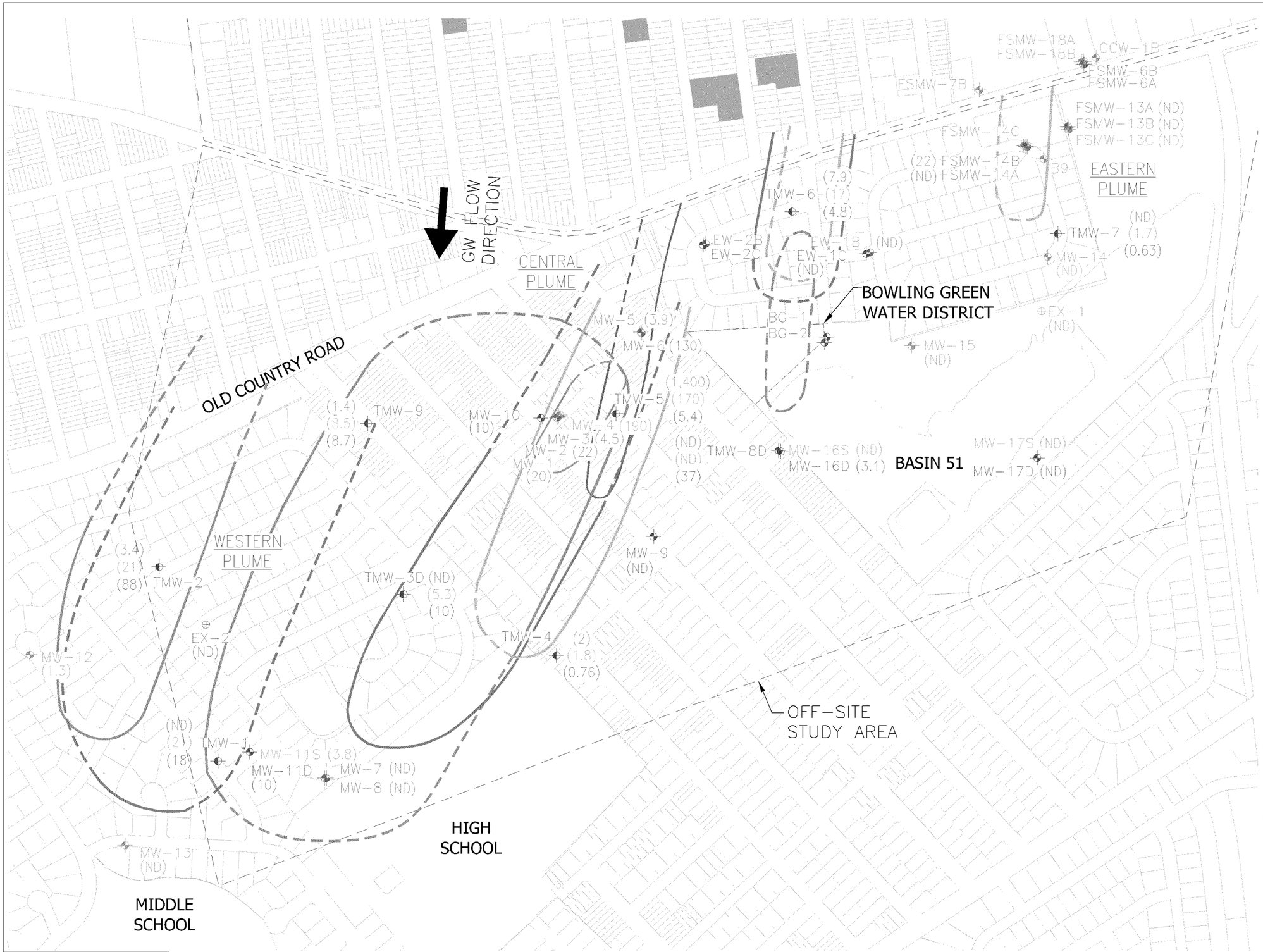

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- SOURCE AREA PROPERTIES
- BGS — BELOW GROUND SURFACE
- PPB — PART PER BILLION
- ug/l — MICROGRAMS PER LITER
- TCA — 1,1,1 – TRICHLOROETHANE
- < 175 FEET BGS
- 175 – 250 FEET BGS
- > 250 FEET BGS
- 100 PPB (ug/l) TCA ISO CONCENTRATION CENTER AT 150 FEET BGS (DASHED WHERE INFERRED)
- 100 PPB (ug/l) TCA ISO CONCENTRATION CENTER AT 200 FEET BGS (DASHED WHERE INFERRED)
- 100 PPB (ug/l) TCA ISO CONCENTRATION CENTER AT 285 FEET BGS (DASHED WHERE INFERRED)
- (800) TCA CONCENTRATION AT 150 FEET BGS
- (11,000) TCA CONCENTRATION AT 200 FEET BGS
- (9.2) TCA CONCENTRATION AT 285 FEET BGS
- 5 PPB TCA ISO CONCENTRATION CENTER AT 150 FT BGS (DASHED WHERE INFERRED)
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NOTES:

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3. TMW-3D AND 8D WERE SAMPLED AT MULTIPLE DEPTHS FROM GROUNDWATER SURFACE TO A TOTAL DEPTH OF 502 FEET BELOW GROUND SURFACE.

GRAPHIC SCALE

200 0 200 400

(IN FEET)

1 inch = 200 ft.

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

TCA ISO-CONCENTRATION MAP

Sheet Reference Number:

3-3

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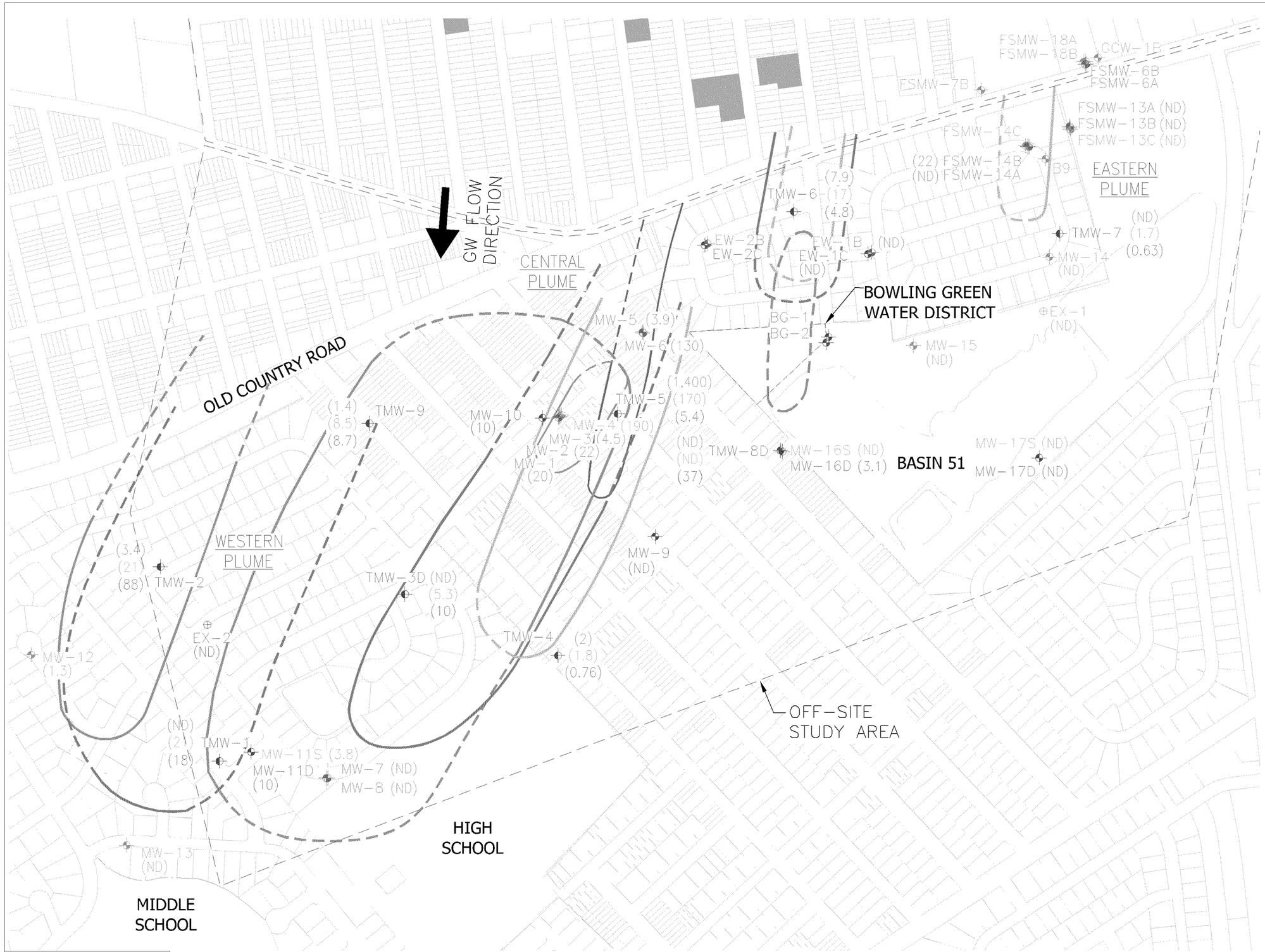

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- (800) — TCA CONCENTRATION AT 150 FEET BGS
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GRAPHIC SCALE

200 0 200 400

(IN FEET)
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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

TCA ISO-CONCENTRATION MAP

Sheet Reference Number:
3-3

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Existing NCIA OU3 Study Area Temporary and Monitoring Wells

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BG-2 (Well #2)	583
EW-1B	164
EW-1C	516
EW-2B	142
EW-2C	514
FSMW-13A	79
FSMW-13B	129
FSMW-13C	249
FSMW-14A	139
FSMW-14B	169
FSMW-14C	249
FSMW-6B	148
FSMW-7B	148
GWHP-01	150
GWHP-02	150
GWHP-03	150
GWHP-04	150
MW-1	110
MW-2	130
MW-3	150
MW-4	200
MW-5	110
MW-6	130
MW-7	110
MW-8	139
MW-10	285
MW-11 S	225
MW-11 D	285
MW-12	225
MW-13	210
MW-14	205
MW-15	205
MW-16 S	225
MW-16 D	285
MW-17 S	225
MW-17 D	285
EX-1	205
EX-2	285
N-10476	130
N-10478	121
N-11852	95
NRMW-1	70
NRMW-3	70
TMW-1	285
TMW-2	285
TMW-3D	502
TMW-4	285
TMW-5	285
TMW-6	285
TMW-7	285
TMW-8D	502
TMW-9	280

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(IN FEET)
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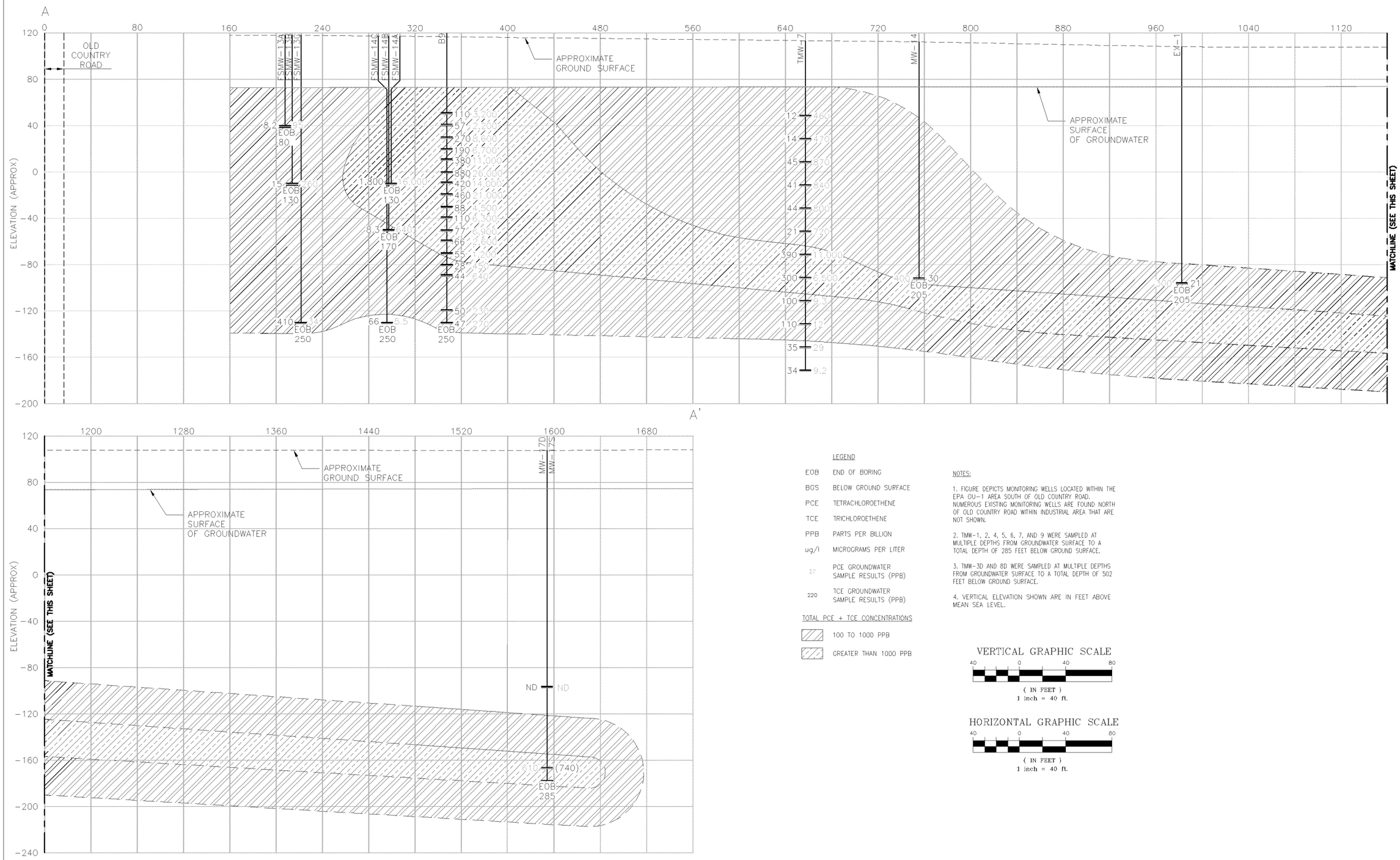
NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

EASTERN PLUME CROSS SECTION
PLAN VIEW

Sheet Reference Number:
3-4



LEGEND

EOB	END OF BORING
BGS	BELOW GROUND SURFACE
PCE	TETRACHLOROETHENE
TCE	TRICHLOROETHENE
PPB	PARTS PER BILLION
ug/l	MICROGRAMS PER LITER
27	PCE GROUNDWATER SAMPLE RESULTS (PPB)
220	TCE GROUNDWATER SAMPLE RESULTS (PPB)

TOTAL PCE + TCE CONCENTRATIONS

- 100 TO 1000 PPB
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VERTICAL GRAPHIC SCALE

40 0 40 80

(IN FEET)
1 inch = 40 ft.

HORIZONTAL GRAPHIC SCALE

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

EASTERN PLUME CROSS SECTION VIEW

Sheet Reference Number:
3-5

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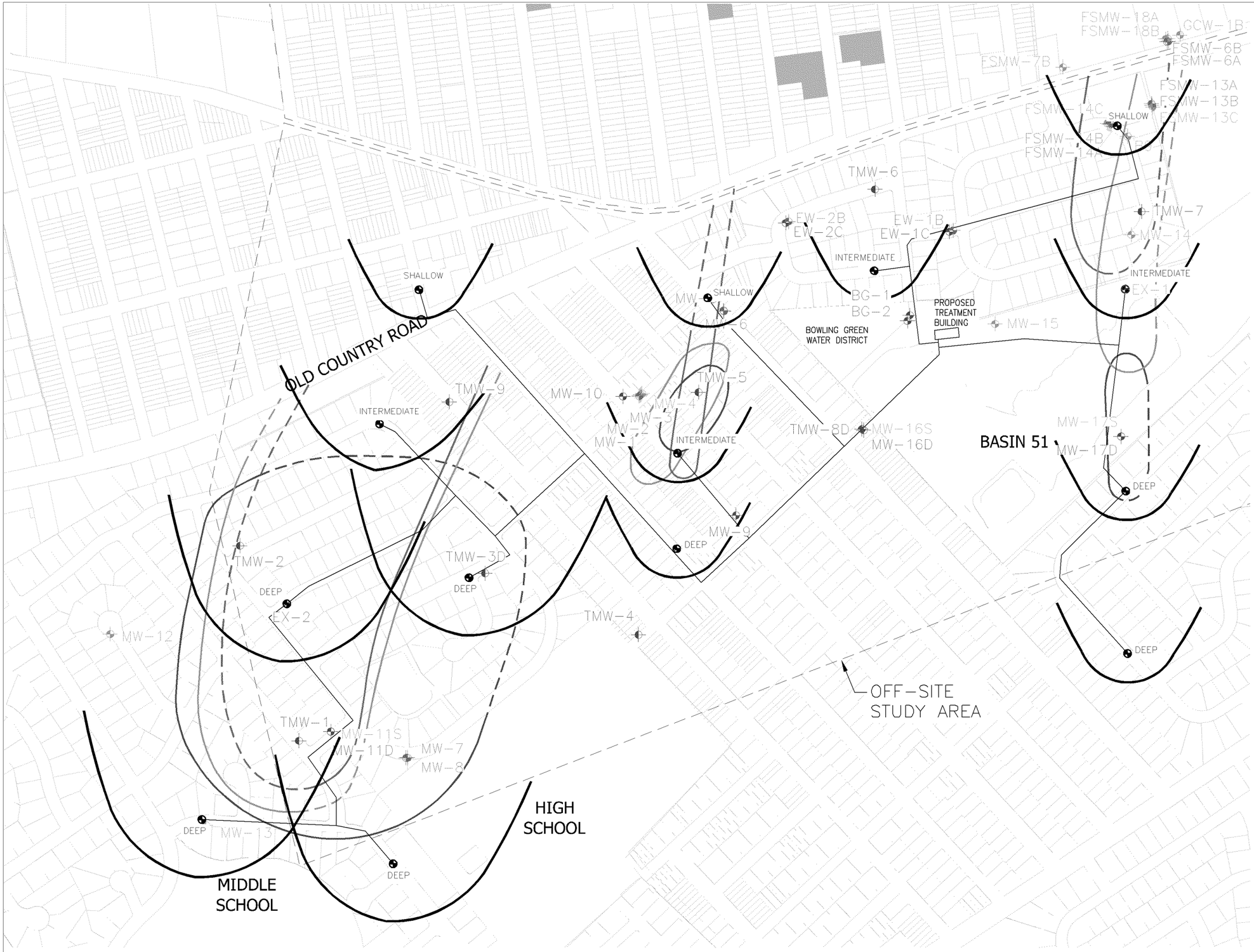

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- PROPOSED TREATMENT BUILDING
- PROPOSED GROUNDWATER TRANSMISSION LINE
- EXTRACTION WELL AND CAPTURE ZONE – PUMPED AT 100 GPM
- EXTRACTION WELL AND CAPTURE ZONE – PUMPED AT 80 GPM
- EXTRACTION WELL AND CAPTURE ZONE – PUMPED AT 50 GPM

GRAPHIC SCALE

200 0 200 400

(IN FEET)

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

ALTERNATIVE 8B
GROUNDWATER EXTRACTION / AIR STRIPPING FULL TREATMENT

Sheet Reference Number:

4 – 1

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- PROPOSED AIR LINE
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- PROPOSED IN-WELL VAPOR STRIPPING WELL

GRAPHIC SCALE

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(IN FEET)

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

ALTERNATIVE 8A
IN-WELL AIR STRIPPING
FULL TREATMENT

Sheet Reference Number:

4-2

N

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GRAPHIC SCALE

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(IN FEET)
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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

EASTERN PLUME CROSS SECTION
PLAN VIEW

Sheet Reference Number:
3-4

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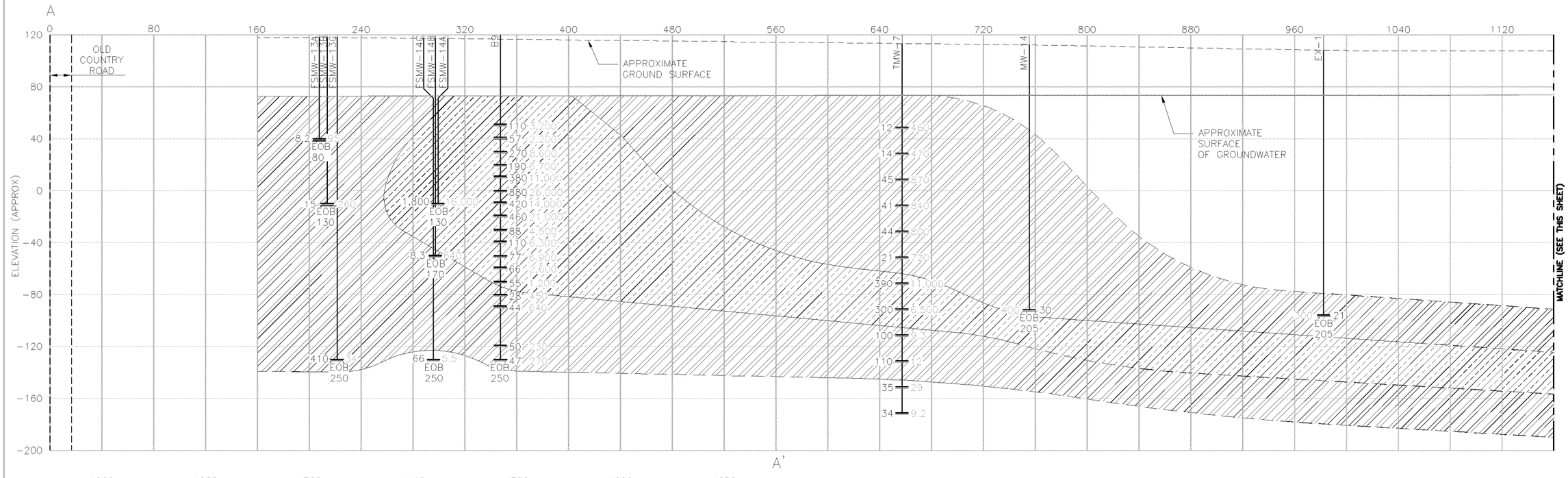

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VERTICAL GRAPHIC SCALE

40 0 40 80

(IN FEET)
1 inch = 40 ft.

HORIZONTAL GRAPHIC SCALE

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(IN FEET)
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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

EASTERN PLUME CROSS SECTION VIEW

Sheet Reference Number:
3-5

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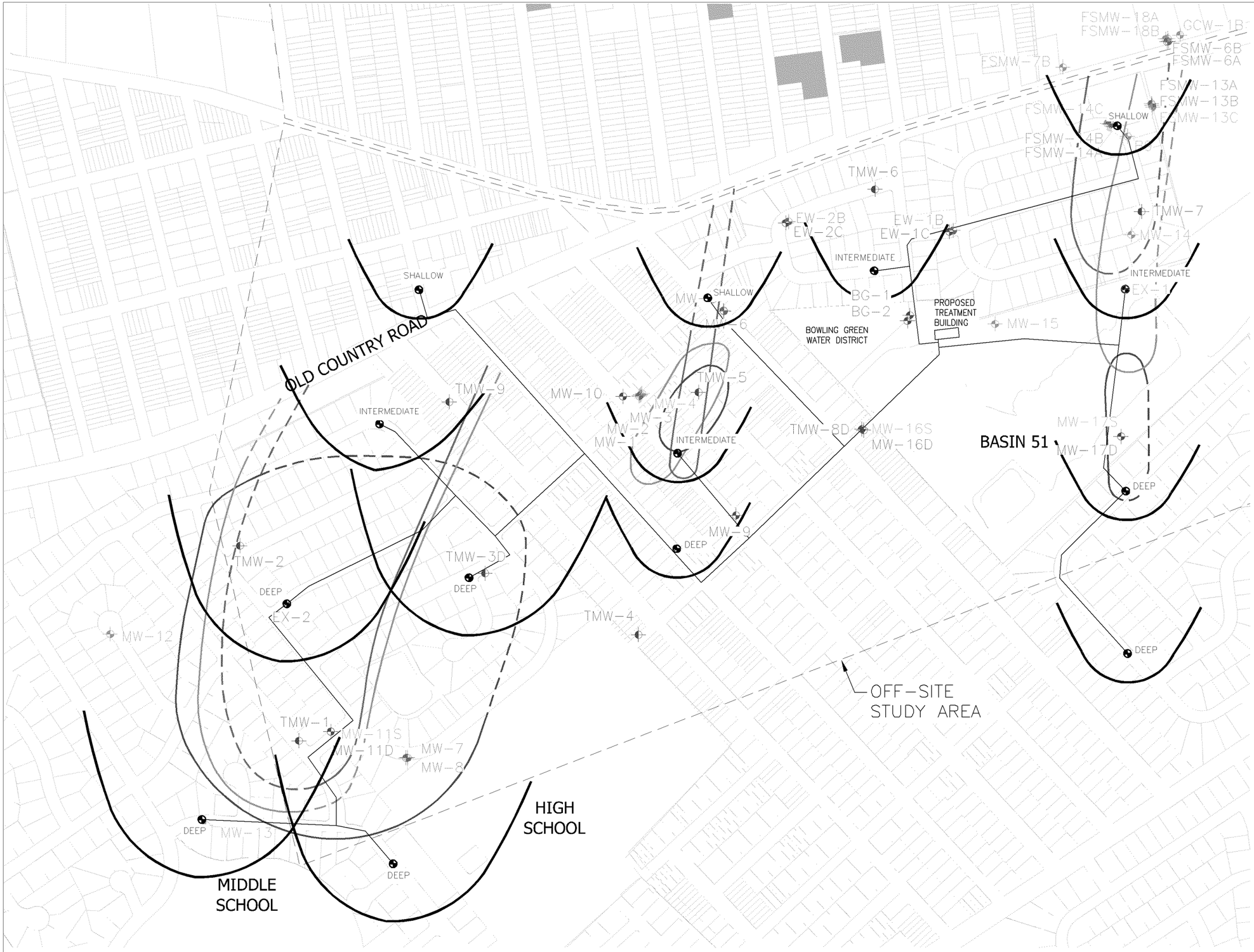

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

ALTERNATIVE 8B
GROUNDWATER EXTRACTION / AIR STRIPPING FULL TREATMENT

Sheet Reference Number:

4 – 1

ED_001164_00019913-00043

LEGEND:

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- MW-5 — MONITORING WELL LOCATION
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- PROPOSED AIR LINE
- PROPOSED TREATMENT BUILDING
- PROPOSED IN-WELL VAPOR STRIPPING WELL

GRAPHIC SCALE

200 0 200 400

(IN FEET)

1 inch = 200 ft.

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NEW CASSEL INDUSTRIAL AREA
NORTH HEMPSTEAD, NEW YORK

ALTERNATIVE 8A
IN-WELL AIR STRIPPING
FULL TREATMENT

Sheet Reference Number:

4-2

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Tables

Table 4-1: Increase in Flow Rates		
Alternative	**Original Flow Rate**	**Updated Flow Rate**
Alternative 4B	100gpm	175gpm
Alternative 5B	100gpm	220gpm
Alternative 6B	260gpm	535gpm
Alternative 7B	280gpm	760gpm

Table 4-2: In-Well Vapor Stripping FS Assumptions		
Well Depth	**Pump Rate**	**Radius of Influence**
80 ft bgs	40 gpm	120 ft
125 ft bgs	10 gpm	250 ft
140 ft bgs	40 gpm	175 ft
200 ft bgs	10 gpm	325 ft
225 ft bgs	10 gpm	510 ft

Table 4-3: Increase in In-Well Vapor Stripping Wells		
Alternative	**Original Number of Wells**	**Updated Number of Wells**
Alternative 4A	4	16
Alternative 5A	6	23
Alternative 6A	9	48
Alternative 7A	13	73*
Alternative 8A	11	77*

*Number of wells needed to cover three separate plume areas.

Table 5-1: Evaluation of Alternatives

Alt. No.	Alternative Name	Overall Protection of Public Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume of Contamination thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness
1	**Alternative 1: No Action**	Minimal prevention of human contact through institutional controls only. Contaminants remain in the environment.	Will not quickly or actively achieve groundwater ARARs.	Does not provide long-term effectiveness or permanence; contaminants will remain in the groundwater.	May allow natural processes to dissipate groundwater contaminants, but will not create any reduction in the toxicity, mobility, or volume of groundwater contaminants as no active remedial measures are included.	Does not result in disruption of normal residential/institutional activities or pose a short term threat to health or the environment.	No major constraints to implementation of institutional measures.	Capital Cost: $31,000 Average Annual O&M: $2,300 Total Present Worth: $71,000
2	**Alternative 2: Monitored Natural Attenuation**	Minimal prevention of human contact through institutional controls. Contaminants anticipated to remain in groundwater for several years.	Relies solely on natural attenuation to achieve site ARARs. Will not quickly achieve groundwater ARARs.	Contaminants expected to remain in off-site groundwater for long period of time.	Relies on natural attenuation to reduce toxicity, mobility and volume of contamination present in the groundwater. There is some evidence of natural attenuation occurring in off-site groundwater; however, it is not as effective as active remedies in reducing toxicity, mobility, and volume of VOCs.	Does not result in disruption of normal residential/institutional activities or pose a short term threat to health or the environment.	No major constraints to implementation of institutional measures and monitoring.	Capital Cost: $754,000 Average Annual O&M: $249,000 Total Present Worth: $3.5 million
3	**Alternative 3: Long Term Monitoring, Assessment, and Contingent Remediation**	Minimal prevention of human contact through institutional controls only. Contaminants remain in the environment. However, a technical evaluation of data and remedial options that is to be made annually may lead to implementation of an active remedy (i.e. Alternative 5A)	Will not quickly or actively achieve groundwater ARARs. However, a technical evaluation of data and remedial options that is to be made on a yearly basis may lead to implementation of an active remedy.	Does not provide long-term effectiveness or permanence; contaminants will remain in the groundwater. However, an annual technical evaluation of data and remedial options may lead to implementation of an active remedy.	May allow natural processes to dissipate groundwater contaminants, but will not create any reduction in the toxicity, mobility, or volume of groundwater contaminants as no active remedial measures are included. However, a technical evaluation of data and remedial options that is to be made on a yearly basis may lead to implementation of an active remedy.	Does not result in disruption of normal residential/institutional activities or pose a short term threat to health or the environment. However, an annual technical evaluation of data and remedial options may lead to implementation of an active remedy.	No major constraints to implementation of institutional measures and monitoring. However, the implementability of a remedial system (i.e. Alternative 5A) that may be installed in future years will be assessed.	Capital Cost: $699,000 Average Annual O&M: $202,000 Total Present Worth: $2.8 million
4A	**Alternative 4A: Remediation of upper portion of Aquifer (to 125 ft bgs) with In-Well Vapor Stripping/ Centralized Vapor Delivery and Treatment**	Protects human health and the environment by transferring contaminants from the water phase to the vapor phase and treating in ex-situ. Prevents further down-gradient migration of groundwater contaminants that exist at 125 ft bgs and shallower, but addresses only "hot spot" areas. Not as protective as other in-well vapor stripping alternatives.	"Hot spot" remediation only. Natural attenuation anticipated to achieve groundwater standards over time. Only groundwater contamination in upper portion of aquifer is addressed. Air emissions will be controlled to meet ARARs.	The operating time for this in-well vapor stripping system is estimated at 30years. Technology permanently removes captured VOCs, but only "hot spot" areas in the upper potion of aquifer are targeted.	Reduces the mobility and volume of VOCs in the off-site groundwater through in-situ treatment of the groundwater, but less reduction than in Alternative 5, 6, 7 or 8.	Will result in disruption of normal residential/institutional activities during implementation of 16 treatment wells and local subsurface vaults. Moderate piping/trenching for vapor transmission lines and small treatment building. Will generate some noise and traffic, but less than other in-well vapor stripping alternatives.	Equipment for in-well vapor stripping technology is sold by a limited number of vendors. Equipment installation is readily implementable and available depending on site logistics. Treatment wells and vaults can be located in streets (little or no land acquisition required).	Capital Cost: $5,711,000 Average Annual O&M: $817,000 Total Present Worth: $14.2 million

Table 5-1: Evaluation of Alternatives

Alt. No.	Alternative Name	Overall Protection of Public Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume of Contamination thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness
4B	**Alternative 4B: Remediation of Upper Portion of Aquifer (to 125 ft bgs) with Groundwater Extraction/Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection**	Protects human health and the environment by extracting contaminated groundwater from the aquifer and treating it ex-situ. Prevents further down-gradient migration of groundwater contaminants that exist at 125 ft bgs and shallower, but addresses only "hot spot" areas. Not as protective as other pump and treat alternatives.	"Hot spot" remediation only. Natural attenuation anticipated to achieve groundwater standards over time. Only groundwater contamination in upper portion of aquifer is addressed. Air emissions and treated effluent discharge will be controlled to meet ARARs.	The estimated operating time for this pump and treat system is 30 years. Technology permanently removes captured VOCs, but only "hot spot" areas in upper portion of aquifer are targeted.	Reduces volume and mobility of contaminants in groundwater through extraction. VOCs in extracted groundwater reduced by treatment. Less reduction than in Alternative 5, 6, 7 or 8.	Will result in disruption of normal residential/institutional activities during implementation of 4 extraction wells, piping, and an approximately 3200 s.f. central treatment building. Less piping/trenching than other pump and treat alternatives. Will generate some noise and traffic.	Well and piping installation and treatment facility construction can be readily implemented depending on site logistics. Treated water must be re-injected to subsurface. Land will likely need to be acquired for central treatment building and wet wells for groundwater re-injection.	Capital Cost: $5,672,000 Average Annual O&M: $933,000 Total Present Worth: $15.7 million
5A	**Alternative 5A: Remediation of Upper and Deep Portions of Aquifer (to 200 ft bgs) with In-Well Vapor Stripping/ Centralized Vapor Delivery and Treatment**	Protects human health and the environment by transferring contaminants from the water phase to the vapor phase and treating it ex-situ. Prevents further down-gradient migration of contaminants, but addresses only "hot spot" areas. More protective than Alternative 4A, as both upper and deep portions of the aquifer are addressed.	"Hot spot" remediation only. Natural attenuation anticipated to achieve groundwater standards over time. Air emissions will be controlled to meet ARARs.	The operating time for this in-well vapor stripping system is estimated at 30 years. Technology permanently removes captured VOCs, but only "hot spot" areas in upper and deep portions of aquifer are targeted.	Reduced the mobility and volume of VOCs in the off-site groundwater through in-situ treatment of the groundwater, but less reduction than in Alternative 6, 7 or 8.	Will result in disruption of normal residential/institutional activities during implementation of 23 treatment wells and local subsurface vault. Moderate piping/trenching for vapor transmission lines and small treatment building. Will generate some noise and traffic, but less than Alternative 6A and 7A.	Equipment for in-well vapor stripping technology is sold by a limited number of vendors. Equipment installation is readily implementable and available, depending on site logistics. Treatment wells can be located in streets (little or no land acquisition required). Land will need to be acquired for small central vapor treatment building.	Capital Cost: $6,263,000 Average Annual O&M: $829,000 Total Present Worth: $14.8 million
5B	**Alternative 5B: Remediation of Upper and Deep Portions of Aquifer (to 200 ft bgs) with Groundwater Extraction/ Centralized Air Stripping and Vapor Treatment/Effluent Re-Injection**	Protects human health and the environment by extracting contaminated groundwater from the aquifer and treating it ex-situ. Prevents further down-gradient migration of groundwater contaminants, but addresses only "hot spot" areas. More protective than Alternative 4B as both upper and deep portions of the aquifer are addressed.	"Hot spot" remediation only. Natural attenuation anticipated to achieve groundwater standards over time. Air emissions and treated effluent discharge will be controlled to meet ARARs.	The estimated operating time for this pump and treat system is 30 years. Technology permanently removed captured VOCs, but only "hot spot" areas in upper and deep portions of aquifer are targeting.	Reduced volume and mobility of contaminants in groundwater through extraction. VOCs in extracted groundwater reduced by treatment. Less reduction than in Alternative 6, 7 Or 8.	Will result in disruption of normal residential/institutional activities during implementation of 4 extraction wells, piping, and an approximately 3200 s.f. central treatment building. Less piping/trenching than other pump and treat alternatives. Will generate some noise and traffic.	Well and piping installation and treatment facility construction can be readily implemented depending on site logistics. Treated water must be re-injected to subsurface. Land will likely need to be acquired for central treatment building and wet wells for groundwater re-injection.	Capital Cost: $5,834,000 Average Annual O&M: $945,000 Total Present Worth: $15.9 million

Table 5-1: Evaluation of Alternatives

Alt. No.	Alternative Name	Overall Protection of Public Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume of Contamination thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness
6A	**Alternative 6A: Full Plume Remediation of Upper Portion of Aquifer (to 125 ft bgs) with In-Well Vapor Stripping/ Centralized Vapor Delivery and Treatment**	Protects human health and the environment by transferring contaminants from the water phase to the vapor phase and treating it ex-situ. Prevents further down-gradient migration of contaminants that exist at 125 ft bgs and shallower. Class GA groundwater standards are achieved at designated depths. Thus, more protective than Alternative 4A.	Achieves applicable groundwater standards. However, only contamination in upper portion of aquifer is addressed. Air emissions will be controlled to meet ARARs.	The operating time for this in-well vapor stripping system is estimated as 30 years. Technology permanently removes captured VOCs.	Reduces the mobility and volume of VOCs in the off-site groundwater through in-situ treatment of the groundwater.	Will result in disruption of normal residential/institutional activities during implementation of 48 treatment wells and local subsurface vaults. Moderate piping/trenching for vapor transmission lines and small treatment building. Will generate some noise and traffic.	Equipment for in-well vapor stripping technology is sold by a limited number of vendors. Equipment installation is readily implementable and available, depending on site logistics. Treatment wells can be located in streets (little or no land acquisition required). Land will need to be acquired for small central vapor treatment building.	Capital Cost: $7,786,000 Average Annual O&M: $1,111,000 Total Present Worth: $19.2 million
6B	**Alternative 6B: Full Plume Remediation of Upper Portion of Aquifer (to 125 ft bgs) with Groundwater Extraction/ Centralized Air Stripping and Vapor Treatment/ Effluent Re-Injection.**	Protects human health and the environment by extracting contaminated groundwater from the aquifer and treating it ex-situ. Prevents further down-gradient migration of groundwater contaminants that exist at 125 ft bgs and shallower. Class GA groundwater standards are achieved at designated depths. Thus, more protective than Alternative 4B.	Achieves applicable groundwater standards. However, only contamination in upper portion of aquifer is addressed. Air emissions and treated effluent discharge will be controlled to meet ARARs.	The estimated operating time of this pump and treat system is 30 years. Technology permanently removes captured VOCs.	Reduced volume and mobility of contaminants in groundwater through extraction. VOCs in extracted groundwater reduced by treatment.	Will result in disruption of normal residential/institutional activities during implementation of 12 extractions wells, piping, and an approximately 4000 s.f. central treatment building. Will generate some noise and traffic.	Well and piping installation and treatment facility construction can be readily implemented depending on site logistics. Treated water must be re-injected to subsurface. Land will likely need to be acquired for central treatment building and wet wells for groundwater re-injection.	Capital Cost: $7,615,000 Average Annual O&M: $1,451,000 Total Present Worth: $23.0 million
7A	**Alternative 7A: Full Plume Remediation of Upper and Deep Portions of Aquifer (to 200 ft bgs) with In-Well Vapor Stripping/ Centralized Vapor Delivery and Treatment**	Protects human health and the environment by transferring contaminants from the water phase to the vapor phase and treating it ex-situ. Prevents further down-gradient migration of contaminants. Class GA groundwater standards are achieved at designated depths. Both upper and deep portions of aquifer are addressed. Most protective in-well vapor stripping alternative.	Achieves applicable groundwater standards. Air emissions will be controlled to meet ARARs.	The operating time for this in-well vapor stripping system is estimated at 30 years. Technology permanently removes captured VOCs.	Reduces the mobility and volume of VOCs in the off-site groundwater through in-situ treatment o f the groundwater. Most reduction of all in-well vapor stripping alternatives.	Will result in disruption of normal residential/institutional activities during implementation of 73 treatment wells and local subsurface vaults. However, no extensive piping/trenching or large treatment building are required. Will generate some noise and traffic.	Equipment for in-well vapor stripping technology is sold by a limited number of vendors. Equipment installation is readily implementable and available, depending on site logistics. Treatment wells can be located in streets (little or no land acquisition required). Land will need to be acquired for small central vapor treatment building.	Capital Cost: $10,535,000 Average Annual O&M: $1,192,000 Total Present Worth: $22.7 million

Table 5-1: Evaluation of Alternatives

Alt. No.	Alternative Name	Overall Protection of Public Health and the Environment	Compliance with ARARs	Long Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume of Contamination thru Treatment	Short Term Impact and Effectiveness	Implementability	Cost Effectiveness
7B	**Alternative 7B: Full Plume Remediation of Upper and Deep Portions of Aquifer (to 200 ft bgs) with Groundwater Extraction/ Centralized Air Stripping and Vapor Treatment/ Effluent Re-Injection**	Protects human health and the environment by extracting contaminated groundwater from the aquifer and treating it ex-situ. Prevents further down-gradient migration of contaminants. Class GA groundwater standards are achieved at designated depths. Both upper and deep portions of aquifer are addressed. Most protective pump and treat alternative.	Achieves applicable groundwater standards. Air emissions and treated effluent discharge will be controlled to meet ARARs.	The estimated operating time for this pump and treat system is 30 years. Technology permanently removes captured VOCs.	Reduces volume and mobility of contaminants in groundwater through extraction. VOCs in extracted groundwater reduced by treatment. Most reduction of all pump and treat alternatives.	Will result in disruption of normal residential/institutional activities during implementation of 13 extractions wells, piping, and an approximately 4000 s.f. central treatment building. Will generate some noise and traffic.	Well and piping installation and treatment facility construction can be readily implemented, depending on site logistics. Treated water must be re-injected to subsurface. Land will likely need to be acquired for central treatment building and wet wells for groundwater re-injection.	Capital Cost: $8,141,000 Average Annual O&M: $1,525,000 Total Present Worth: $24.2 million
8A	**Alternative 8A: Full Plume Remediation of Upper and Deep Portions of Aquifer with In-Well Vapor Stripping/ Centralized Vapor Delivery and Treatment**	Protects human health and the environment by transferring contaminants from the water phase to the vapor phase and treating it ex-situ. Prevents further down-gradient migration of contaminants. Includes the full capture and treatment of contaminated off-site groundwater to greater designated depths to achieve Class GA groundwater standards. Most protective in-well vapor stripping alternative.	Achieves applicable groundwater standards. Air emissions will be controlled to meet ARARs.	The operating time for this in-well vapor stripping system is estimated at 30 years. Technology permanently removes captured VOCs.	Reduces the mobility and volume of VOCs in the off-site groundwater through in-situ treatment o f the groundwater. Most reduction of all in-well vapor stripping alternatives.	Will result in disruption of normal residential/institutional activities during implementation of 77 treatment wells and local subsurface vaults. Moderate piping/trenching for vapor transmission lines and small treatment building. Will generate some noise and traffic.	Equipment for in-well vapor stripping technology is sold by a limited number of vendors. Equipment installation is readily implementable and available, depending on site logistics. Treatment wells can be located in streets (little or no land acquisition required). Land will need to be acquired for small central vapor treatment building.	Capital Cost: $10,848,000 Average Annual O&M: $1,206,000 Total Present Worth: $23.1 million
8B	**Alternative 8B: Full Plume Remediation of Upper and Deep Portions of Aquifer with Groundwater Extraction/ Centralized Air Stripping and Vapor Treatment/ Effluent Re-Injection**	Protects human health and the environment by extracting contaminated groundwater from the aquifer and treating it ex-situ. Prevents further down-gradient migration of contaminants. Includes the full capture and treatment of contaminated off-site groundwater to greater designated depths to achieve Class GA groundwater standards. Most protective pump and treat alternative.	Achieves applicable groundwater standards. Air emissions and treated effluent discharge will be controlled to meet ARARs.	The estimated operating time for this pump and treat system is 30 years. Technology permanently removes captured VOCs.	Reduces volume and mobility of contaminants in groundwater through extraction. VOCs in extracted groundwater reduced by treatment. Most reduction of all pump and treat alternatives.	Will result in disruption of normal residential/institutional activities during implementation of 13 extractions wells, piping, and an approximately 4000 s.f. central treatment building. Will generate some noise and traffic.	Well and piping installation and treatment facility construction can be readily implemented, depending on site logistics. Treated water must be re-injected to subsurface. Land will likely need to be acquired for central treatment building and wet wells for groundwater re-injection.	Capital Cost: $8,698,000 Average Annual O&M: $1,546,000 Total Present Worth: $24.9 million

Table 5-2 Cost Estimate for Alternative 8B

Alternative 8B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 8B includes full plume remediation of the upper and deep portions of the aquifer with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	Pre-Design Investigation		$	1,372,000
2	Mobilization and Demobilization		$	250,000
3	Extraction Well Installation		$	568,000
4	Transmission Piping		$	1,233,000
5	Groundwater Treatment System		$	1,000,000
6	Treatment Plant Building		$	1,200,000
7	Infiltration Wells		$	620,000
8	Reporting and Institutional Controls		$	175,000
	Sub-Total		$	6,418,000
	Contingency	25%	$	1,605,000
	Sub-Total		$	8,023,000
	Project Management		$	150,000
	Remedial Design		$	250,000
	Permitting		$	100,000
	Construction Management		$	50,000
	Construction Oversight		$	125,000
	TOTAL CAPITAL COST		$	8,698,000

ANNUAL O&M COST: Item No.	Description	Quantity		Total
Years 1 - 5				
1	Operation		$	594,000
2	Maintenance		$	29,000
3	Performance Sampling		$	66,000
4	Monitoring and Institutional Controls		$	196,000
	Sub-Total		$	885,000
	Contingency	10%	$	89,000
	Sub-Total		$	974,000
	TOTAL ANNUAL O&M COSTS		$	974,000

Table 5-2 Cost Estimate for Alternative 8B

Alternative 8B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 8B includes full plume remediation of the upper and deep portions of the aquifer with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**594,000**
2	**Maintenance**		$	**29,000**
3	**Performance Sampling**		$	**66,000**
4	**Monitoring and Institutional Controls**		$	**99,000**
	Sub-Total		$	**788,000**
	Contingency	10%	$	**79,000**
	Sub-Total		$	**867,000**
	TOTAL ANNUAL O&M COSTS		$	**867,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**1,900**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**1,149,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**8,698,000**
2	**Total Annual O&M Cost**				
	2.1 Year 1-5	1-5	$ 973,000	$	**4,345,000**
	2.2 Years 6-30	6-30	$ 867,000	$	**11,332,000**
3	**Periodic Costs**			$	**559,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**24,934,000**

Table 5-3 Updated Cost Estimate for Alternative 1

Alternative 1
NO ACTION

COST ESTIMATE SUMMARY

Site: New Cassel Industrial Area Offsite Groundwater
Location: Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 1 consists of no action except for the implementation of institutional controls.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Institutional Measures**		**$**	**25,000**
	Sub-Total		**$**	**25,000**
	Contingency	25%	**$**	**6,000**
	Sub-Total		**$**	**31,000**
	TOTAL CAPITAL COST		**$**	**31,000**

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
1	**Monitoring and Institutional Controls**		**$**	**2,000**
1.1	Maintain Institutional Controls			
	Sub-Total		**$**	**2,000**
	Contingency	15%	**$**	**300**
	Sub-Total		**$**	**2,300**
	TOTAL ANNUAL O&M COST		**$**	**2,300**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		**$**	**31,000**
2	**Total Annual O&M Cost**	1-30	$2,300	**$**	**40,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			**$**	**71,000**

Table 5-4 Updated Cost Estimate for Alternative 2

Alternative 2
Monitored Natural Attenuation

COST ESTIMATE SUMMARY

Site: New Cassel Industrial Area Offsite Groundwater
Location: Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 2 consists of Monitored Natural Attenuation.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Site Characterization**		**$**	**358,000**
2	**Reporting and Institutional Controls**		**$**	**105,000**
	Sub-Total		**$**	**463,000**
	Contingency	25%	**$**	**116,000**
	Sub-Total		**$**	**579,000**
	Project Management		**$**	**100,000**
	Permitting		**$**	**75,000**
	TOTAL CAPITAL COST		**$**	**754,000**
ANNUAL O&M COST:				
Item No.	**Description**	**Quantity**		**Total**
Years 1 - 2				
1	**MNA & Institutional Controls**		**$**	**318,000**
1.1	Quarterly Groundwater Monitoring			
	Sub-Total		**$**	**318,000**
	Contingency	10%	**$**	**31,800**
	Sub-Total		**$**	**349,800**
	TOTAL ANNUAL O&M COST		**$**	**349,800**
Years 3-5				
1	**MNA & Institutional Controls**			
1.1	Semiannual Groundwater Monitoring		**$**	**161,000**
	Sub-Total		**$**	**161,000**
	Contingency	10%	**$**	**16,100**
	Sub-Total		**$**	**177,100**
	TOTAL ANNUAL O&M COST		**$**	**177,100**

Table 5-4 Updated Cost Estimate for Alternative 2

Alternative 2
Natural Monitored Attenuation

COST ESTIMATE SUMMARY

Site: New Cassel Industrial Area Offsite Groundwater
Location: Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 2 consists of Monitored Natural Attenuation.

Item No.	Description	Quantity		Total
Years 6-30				
1	**MNA & Institutional Controls**			
1.1	Annual Groundwater Monitoring		$	81,450
	Sub-Total		$	81,450
	Contingency	10%	$	8,145
	Sub-Total		$	89,595
	TOTAL ANNUAL O&M COST		$	89,595

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Long Term Maintenance & Five Year Review**	5	$	65,000
2	**Decommission Wells**	30	$	710,000

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	754,000
2	**Total Annual O&M Cost**				
2.1	**Years 1 - 2**	1-2	$ 349,580	$	660,000
2.2	**Years 3 - 5**	3-5	$ 176,990	$	452,000
2.3	**Years 6 - 30**	6-30	$ 89,595	$	1,171,000
3	**Periodic Costs**			$	417,000
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	3,454,000

Table 5-5 Updated Cost Estimate for Alternative 3

Alternative 3
Long Term Monitoring

COST ESTIMATE SUMMARY

Site: New Cassel Industrial Area Offsite Groundwater
Location: Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 3 consists of long term monitoring, assessment and a contingency remediation if after review it is determined that implementation of active remedation is necessary.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Long Term Monitoring**		**$**	**314,000**
2	**Reporting and Institutional Controls**		**$**	**105,000**
	Sub-Total		**$**	**419,000**
	Contingency	25%	**$**	**105,000**
	Sub-Total		**$**	**524,000**
	Project Management		**$**	**100,000**
	Permitting		**$**	**75,000**
	TOTAL CAPITAL COST		**$**	**699,000**
ANNUAL O&M COST:				
Item No.	**Description**	**Quantity**		**Total**
Years 1 - 2				
1	**Long Term Monitoring & Institutional Controls**		**$**	**254,000**
1.1	Quarterly Groundwater Monitoring			
	Sub-Total		**$**	**254,000**
	Contingency	10%	**$**	**25,400**
	Sub-Total		**$**	**279,400**
	TOTAL ANNUAL O&M COST		**$**	**279,400**
Years 3-5				
1	**Long Term Monitoring & Institutional Controls**			
1.1	Semiannual Groundwater Monitoring		**$**	**117,000**
	Sub-Total		**$**	**117,000**
	Contingency	10%	**$**	**11,700**
	Sub-Total		**$**	**128,700**
	TOTAL ANNUAL O&M COST		**$**	**128,700**

Table 5-5 Updated Cost Estimate for Alternative 3

Alternative 3
Long Term Monitoring

COST ESTIMATE SUMMARY

Site: New Cassel Industrial Area Offsite Groundwater
Location: Nassau County, New York
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 3 consists of long term monitoring, assessment and a contingency remediation if after review it is determined that implementation of active remedation is necessary.

Item No.	Description	Quantity		Total
Years 6-30				
1	**Long Term Monitoring & Institutional Controls**			
1.1	Annual Groundwater Monitoring		$	59,670
	Sub-Total		$	59,670
	Contingency	10%	$	5,967
	Sub-Total		$	65,637
	TOTAL ANNUAL O&M COST		$	65,637

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Long Term Maintenance & Five Year Review**	5	$	65,000
2	**Decommission Wells**	30	$	710,000

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	699,000
2	**Total Annual O&M Cost**				
2.1	**Years 1-2**	1-2	$ 253,748	$	479,000
2.2	**Years 3-5**	3-5	$ 129,074	$	330,000
2.3	**Years 6-30**	6-30	$ 65,637	$	858,000
3	**Periodic Costs**			$	417,000
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	2,783,000

Table 5-6 Updated Cost Estimate for Alternative 4A

Alternative 4A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 4A consists of remediating the upper portion (to 125 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping, and in-situ remediation technology, and centralized off-gas treatment.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	**1,174,000**
2	**Pilot / Treatability Study**		$	**113,000**
3	**Mobilization and Demobilization**		$	**250,000**
4	**Well Installation**		$	**429,000**
5	**In Well Treatment System**		$	**399,000**
6	**Vapor Transmission Pipe**		$	**883,000**
7	**Centralized Vapor Treatment System**		$	**186,000**
8	**Treatment Plant Building**		$	**420,000**
9	**Reporting and Site Management**		$	**175,000**
	Sub-Total			**$4,029,000**
	Contingency	25%	$	**1,007,000**
	Sub-Total		$	**5,036,000**
	Project Management		$	**150,000**
	Remedial Design		$	**250,000**
	Permitting		$	**100,000**
	Construction Management		$	**50,000**
	Construction Oversight		$	**125,000**
	TOTAL CAPITAL COST		$	5,711,000

ANNUAL O&M COST:

Item No.	Description	Quantity		Total
Years 1-5				
1	**Operation**		$	**249,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**162,000**
	Sub-Total		$	**475,000**
	Contingency	10%	$	**48,000**
	Sub-Total		$	**523,000**
	TOTAL ANNUAL O&M COSTS		$	523,000

Table 5-6 Updated Cost Estimate for Alternative 4A

Alternative 4A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 4A consists of remediating the upper portion (to 125 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping, and in-situ remediation technology, and centralized off-gas treatment.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	Operation		$	249,000
2	Maintenance		$	5,000
3	Performance Monitoring		$	54,000
4	Monitoring and Institutional Controls		$	82,000
	Sub-Total		$	390,000
	Contingency	10%	$	39,000
	Sub-Total		$	429,000
	TOTAL ANNUAL O&M COSTS		$	429,000

PERIODIC COSTS:

Item No.	Description	Year		Total
1	Carbon Profiling	1	$	950
2	Long Term Maintenance & Five Year Review	5	$	65,000
3	System Decommissioning	30	$	1,011,500

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	Capital Cost	0		$	5,711,000
2	Total Annual O&M Cost				
2.1	Year 1 - 5	1-5	$ 523,050	$	2,336,000
2.2	Year 6 - 30	6-30	$ 429,025	$	5,609,000
3	Periodic Costs			$	514,000
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	14,170,000

Table 5-7 Updated Cost Estimate for Alternative 4B

Alternative 4B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 4B includes the treatment of the contaminated groundwater to a depth of 125 ft bgs via extraction wells. Extracted groundwater will be treated at a centralized treatment system consisting of air stripper and vapor treatment. Treated effluent will then be re-injected into the ground. This alternative addresses "hot-spot" areas within the off site contaminant plumes and assumes that natural attentuation would remediate a portion of the off-site groundwater over time.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	Pre-Design Investigation		$	1,182,000
2	Mobilization and Demobilization		$	250,000
3	Extraction Well Installation		$	174,000
4	Transmission Piping		$	358,200
5	Groundwater Treatment System		$	725,000
6	Treatment Plant Building		$	1,080,000
7	Infiltration Wells		$	133,500
8	Reporting and Institutional Controls		$	175,000
	Sub-Total		$	4,077,700
	Contingency	25%	$	1,019,000
	Sub-Total		$	5,096,700
	Project Management		$	125,000
	Remedial Design		$	200,000
	Permitting		$	100,000
	Construction Management		$	50,000
	Construction Oversight		$	100,000
	TOTAL CAPITAL COST		$	5,672,000

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
Years 1 - 5				
1	Operation		$	309,000
2	Maintenance		$	14,000
3	Performance Sampling		$	66,000
4	Monitoring and Institutional Controls		$	168,000
	Sub-Total		$	557,000
	Contingency	10%	$	56,000
	Sub-Total		$	613,000
	TOTAL ANNUAL O&M COSTS		$	613,000

Table 5-7 Updated Cost Estimate for Alternative 4B

Alternative 4B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 4B includes the treatment of the contaminated groundwater to a depth of 125 ft bgs via extraction wells. Extracted groundwater will be treated at a centralized treatment system consisting of air stripper and vapor treatment. Treated effluent will then be re-injected into the ground. This alternative addresses "hot-spot" areas within the off site contaminant plumes and assumes that natural attentuation would remediate a portion of the off-site groundwater over time.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**309,000**
2	**Maintenance**		$	**14,000**
3	**Performance Sampling**		$	**66,000**
4	**Monitoring and Institutional Controls**		$	**85,000**
	Sub-Total		$	**474,000**
	Contingency	10%	$	**47,000**
	Sub-Total		$	**521,000**
	TOTAL ANNUAL O&M COSTS		$	**521,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling - Vapor Phase GAC**	1	$	**950**
2	**Carbon Profiling - Liquid Phase GAC**	5	$	**950**
3	**Long Term Maintenance & Five Year Review**		$	**12,500**
4	**Long Term Maintenance**		$	**65,000**
5	**System Decommissioning**	30	$	**512,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**5,672,000**
2	**Total Annual O&M Cost**				
	2.1 Year 1-5	1-5	$ 614,000	$	**2,741,000**
	2.2 Years 6-30	6-30	$ 522,000	$	**6,817,000**
3	**Periodic Costs**			$	**422,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**15,652,000**

Table 5-8 Updated Cost Estimate for Alternative 5A

Alternative 5A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 5A consists of remediating the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping, and in-situ remediation technology, and centralized off-gas treatment.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	**1,256,000**
2	**Pilot / Treatability Study**		$	**113,000**
3	**Mobilization and Demobilization**		$	**250,000**
4	**Well Installation**		$	**713,000**
5	**In Well Treatment System**		$	**509,000**
6	**Vapor Transmission Pipe**		$	**928,000**
7	**Centralized Vapor Treatment System**		$	**186,000**
8	**Treatment Plant Building**		$	**420,000**
9	**Reporting and Site Management**		$	**175,000**
	Sub-Total		$	**4,550,000**
	Contingency	25%	$	**1,138,000**
	Sub-Total		$	**5,688,000**
	Project Management		$	**125,000**
	Remedial Design		$	**200,000**
	Permitting		$	**100,000**
	Construction Management		$	**50,000**
	Construction Oversight		$	**100,000**
	TOTAL CAPITAL COST		$	6,263,000

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
Years 1-5				
1	**Operation**		$	**249,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**168,000**
	Sub-Total		$	**481,000**
	Contingency	10%	$	**48,000**
	Sub-Total		$	**529,000**
	TOTAL ANNUAL O&M COSTS		$	529,000

Table 5-8 Updated Cost Estimate for Alternative 5A

Alternative 5A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 5A consists of remediating the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping, and in-situ remediation technology, and centralized off-gas treatment.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**249,000**
2	**Maintenance**		$	**5,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**85,000**
	Sub-Total		$	**393,000**
	Contingency	10%	$	**39,000**
	Sub-Total		$	**432,000**
	TOTAL ANNUAL O&M COSTS		$	**432,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**950**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**1,087,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**6,263,000**
2	**Total Annual O&M Cost**				
2.1	**Year 1 - 5**	1-5	$ 529,000	$	**2,364,000**
2.2	**Year 6 - 30**	6-30	$ 432,000	$	**5,649,000**
3	**Periodic Costs**			$	**538,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**14,814,000**

Table 5-9 Updated Cost Estimate for Alternative 5B

Alternative 5B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 5B consists of remediating the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing groundwater extraction to a centralized treatment system consisting of air stripping and vapor treatment and then re-injection of the treated effluent into the ground.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	**1,264,000**
2	**Mobilization and Demobilization**		$	**250,000**
3	**Extraction Well Installation**		$	**174,000**
4	**Transmission Piping**		$	**382,600**
5	**Groundwater Treatment System**		$	**725,000**
6	**Treatment Plant Building**		$	**1,080,000**
7	**Infiltration Wells**		$	**156,500**
8	**Reporting and Institutional Controls**		$	**175,000**
	Sub-Total		$	**4,207,100**
	Contingency	25%	$	**1,052,000**
	Sub-Total		$	**5,259,100**
	Project Management		$	**125,000**
	Remedial Design		$	**200,000**
	Permitting		$	**100,000**
	Construction Management		$	**50,000**
	Construction Oversight		$	**100,000**
	TOTAL CAPITAL COST		$	**5,834,000**

ANNUAL O&M COST:

Item No.	Description	Quantity		Total
Years 1 - 5				
1	**Operation**		$	**309,000**
2	**Maintenance**		$	**14,000**
3	**Performance Sampling**		$	**66,000**
4	**Monitoring and Institutional Controls**		$	**174,000**
	Sub-Total		$	**563,000**
	Contingency	10%	$	**56,000**
	Sub-Total		$	**619,000**
	TOTAL ANNUAL O&M COSTS		$	**619,000**

Table 5-9 Updated Cost Estimate for Alternative 5B

Alternative 5B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 5B consists of remediating the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing groundwater extraction to a centralized treatment system consisting of air stripping and vapor treatment and then re-injection of the treated effluent into the ground.

Years 6 - 30

Item No.	Description	Quantity		Total
1	Operation		$	309,000
2	Maintenance		$	14,000
3	Performance Sampling		$	66,000
4	Monitoring and Institutional Controls		$	88,000
	Sub-Total		$	477,000
	Contingency	10%	$	48,000
	Sub-Total		$	525,000
	TOTAL ANNUAL O&M COSTS		$	525,000

PERIODIC COSTS:

Item No.	Description	Year		Total
1	Carbon Profiling - Vapor Phase GAC	1	$	950
2	Carbon Profiling - Liquid Phase GAC	5	$	950
3	Long Term Maintenance & Five Year Review		$	16,500
4	Long Term Maintenance		$	65,000
5	System Decommissioning	30	$	542,000

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	Capital Cost	0		$	5,834,000
2	Total Annual O&M Cost				
2.1	Year 1-5	1-5	$ 620,000	$	2,768,000
2.2	Years 6-30	6-30	$ 526,000	$	6,871,000
3	Periodic Costs			$	452,000
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	15,925,000

Table 5-10 Updated Cost Estimate for Alternative 6A

Alternative 6A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 6A consists of full plume remediation of the upper portion (to 125 ft bgs) with in-well vapor stripping and centralized vapor treatment. This alternative is similar to Alt 4A but includes full capture and treatment of contaminated off site groundwater.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	**1,174,000**
2	**Pilot / Treatability Study**		$	**113,000**
3	**Mobilization and Demobilization**		$	**250,000**
4	**Well Installation**		$	**1,256,000**
5	**In Well Treatment System**		$	**993,000**
6	**Vapor Transmission Pipe**		$	**1,097,000**
7	**Centralized Vapor Treatment System**		$	**211,000**
8	**Treatment Plant Building**		$	**420,000**
9	**Reporting and Site Management**		$	**175,000**
	Sub-Total			**$5,689,000**
	Contingency	25%	$	**1,422,000**
	Sub-Total		$	**7,111,000**
	Project Management		$	**150,000**
	Remedial Design		$	**250,000**
	Permitting		$	**100,000**
	Construction Management		$	**50,000**
	Construction Oversight		$	**125,000**
	TOTAL CAPITAL COST		$	7,786,000

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
Years 1-5				
1	**Operation**		$	**394,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**162,000**
	Sub-Total		$	**620,000**
	Contingency	10%	$	**62,000**
	Sub-Total		$	**682,000**
	TOTAL ANNUAL O&M COSTS		$	682,000

Table 5-10 Updated Cost Estimate for Alternative 6A

Alternative 6A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 6A consists of full plume remediation of the upper portion (to 125 ft bgs) with in-well vapor stripping and centralized vapor treatment. This alternative is similar to Alt 4A but includes full capture and treatment of contaminated off site groundwater.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**394,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**82,000**
	Sub-Total		$	**540,000**
	Contingency	10%	$	**54,000**
	Sub-Total		$	**594,000**
	TOTAL ANNUAL O&M COSTS		$	**594,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**950**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**1,331,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**7,786,000**
2	**Total Annual O&M Cost**				
2.1	**Year 1 - 5**	1-5	$ 682,000	$	**3,046,000**
2.2	**Year 6 - 30**	6-30	$ 594,000	$	**7,766,000**
3	**Periodic Costs**			$	**616,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**19,214,000**

Table 5-11 Updated Cost Estimate for Alternative 6B

Alternative 6B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 6B includes the full plume remediation of the upper portion of the aquifer (to 125 ft bgs) with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	Pre-Design Investigation		$	1,182,000
2	Mobilization and Demobilization		$	250,000
3	Extraction Well Installation		$	523,000
4	Transmission Piping		$	933,400
5	Groundwater Treatment System		$	925,000
6	Treatment Plant Building		$	1,200,000
7	Infiltration Wells		$	363,500
8	Reporting and Institutional Controls		$	175,000
	Sub-Total		$	5,551,900
	Contingency	25%	$	1,388,000
	Sub-Total		$	6,939,900
	Project Management		$	150,000
	Remedial Design		$	250,000
	Permitting		$	100,000
	Construction Management		$	50,000
	Construction Oversight		$	125,000
	TOTAL CAPITAL COST		$	7,615,000

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
Years 1 - 5				
1	Operation		$	561,000
2	Maintenance		$	29,000
3	Performance Sampling		$	66,000
4	Monitoring and Institutional Controls		$	181,000
	Sub-Total		$	837,000
	Contingency	10%	$	84,000
	Sub-Total		$	921,000
	TOTAL ANNUAL O&M COSTS		$	921,000

Table 5-11 Updated Cost Estimate for Alternative 6B

Alternative 6B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 6B includes the full plume remediation of the upper portion of the aquifer (to 125 ft bgs) with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**561,000**
2	**Maintenance**		$	**29,000**
3	**Performance Sampling**		$	**66,000**
4	**Monitoring and Institutional Controls**		$	**91,000**
	Sub-Total		$	**747,000**
	Contingency	10%	$	**75,000**
	Sub-Total		$	**822,000**
	TOTAL ANNUAL O&M COSTS		$	**822,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**1,900**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**904,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**7,615,000**
2	**Total Annual O&M Cost**				
	2.1 Year 1-5	1-5	$ 920,000	$	**4,111,000**
	2.2 Years 6-30	6-30	$ 822,000	$	**10,747,000**
3	**Periodic Costs**			$	**480,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**22,953,000**

Table 5-12 Updated Cost Estimate for Alternative 7A

Alternative 7A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 7A consists of full plume remediation of the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping and centralized off-gas treatment.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	1,256,000
2	**Pilot / Treatability Study**		$	113,000
3	**Mobilization and Demobilization**		$	250,000
4	**Well Installation**		$	2,747,000
5	**In Well Treatment System**		$	1,444,000
6	**Vapor Transmission Pipe**		$	1,272,000
7	**Centralized Vapor Treatment System**		$	211,000
8	**Treatment Plant Building**		$	420,000
9	**Reporting and Site Management**		$	175,000
	Sub-Total			$7,888,000
	Contingency	25%	$	1,972,000
	Sub-Total		$	9,860,000
	Project Management		$	150,000
	Remedial Design		$	250,000
	Permitting		$	100,000
	Construction Management		$	50,000
	Construction Oversight		$	125,000
	TOTAL CAPITAL COST		$	10,535,000

ANNUAL O&M COST:

Item No.	Description	Quantity		Total
Years 1-5				
1	**Operation**		$	424,000
2	**Maintenance**		$	10,000
3	**Performance Monitoring**		$	54,000
4	**Monitoring and Institutional Controls**		$	168,000
	Sub-Total		$	656,000
	Contingency	10%	$	66,000
	Sub-Total		$	722,000
	TOTAL ANNUAL O&M COSTS		$	722,000

Table 5-12 Updated Cost Estimate for Alternative 7A

Alternative 7A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 7A consists of full plume remediation of the upper and deep portions (to 200 ft bgs) of the off-site groundwater contaminant plume by implementing in-well vapor stripping and centralized off-gas treatment.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**424,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**85,000**
	Sub-Total		$	**573,000**
	Contingency	10%	$	**57,000**
	Sub-Total		$	**630,000**
	TOTAL ANNUAL O&M COSTS		$	630,000

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**950**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**1,587,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**10,535,000**
2	**Total Annual O&M Cost**				
2.1	**Year 1 - 5**	1-5	$ 722,000	$	**3,226,000**
2.2	**Year 6 - 30**	6-30	$ 630,000	$	**8,238,000**
3	**Periodic Costs**			$	**697,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	22,696,000

Table 5-13 Updated Cost Estimate for Alternative 7B

Alternative 7B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 7B includes full plume remediation of the upper and deep portions of the aquifer (to 200 ft bgs) with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	Pre-Design Investigation		$	1,264,000
2	Mobilization and Demobilization		$	250,000
3	Extraction Well Installation		$	564,000
4	Transmission Piping		$	1,016,800
5	Groundwater Treatment System		$	1,000,000
6	Treatment Plant Building		$	1,200,000
7	Infiltration Wells		$	503,000
8	Reporting and Institutional Controls		$	175,000
	Sub-Total		$	5,972,800
	Contingency	25%	$	1,493,000
	Sub-Total		$	7,465,800
	Project Management		$	150,000
	Remedial Design		$	250,000
	Permitting		$	100,000
	Construction Management		$	50,000
	Construction Oversight		$	125,000
	TOTAL CAPITAL COST		$	8,141,000

Item No.	Description	Quantity		Total
ANNUAL O&M COST:				
Years 1 - 5				
1	Operation		$	594,000
2	Maintenance		$	29,000
3	Performance Sampling		$	66,000
4	Monitoring and Institutional Controls		$	188,000
	Sub-Total		$	877,000
	Contingency	10%	$	88,000
	Sub-Total		$	965,000
	TOTAL ANNUAL O&M COSTS		$	965,000

Table 5-13 Updated Cost Estimate for Alternative 7B

Alternative 7B
PUMP AND TREAT WITH RE-INJECTION

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 7B includes full plume remediation of the upper and deep portions of the aquifer (to 200 ft bgs) with groundwater extraction and centralized treatment using air stripping and vapor treatment. Treated effluent would be re-injected into the ground.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**594,000**
2	**Maintenance**		$	**29,000**
3	**Performance Sampling**		$	**66,000**
4	**Monitoring and Institutional Controls**		$	**95,000**
	Sub-Total		$	**784,000**
	Contingency	10%	$	**78,000**
	Sub-Total		$	**862,000**
	TOTAL ANNUAL O&M COSTS		$	**862,000**

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**1,900**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**997,000**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**8,141,000**
2	**Total Annual O&M Cost**				
	2.1 Year 1-5	1-5	$ 965,000	$	**4,311,000**
	2.2 Years 6-30	6-30	$ 862,000	$	**11,268,000**
3	**Periodic Costs**			$	**510,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	**24,230,000**

Table 5-14 Updated Cost Estimate for Alternative 8A

Alternative 8A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 8A consists of full plume remediation of the upper and deep portions of the off-site groundwater contaminant plume by implementing in-well vapor stripping and centralized off-gas treatment.

Item No.	Description	Quantity		Total
CAPITAL COSTS:				
1	**Pre-Design Investigation**		$	**1,364,000**
2	**Pilot / Treatability Study**		$	**113,000**
3	**Mobilization and Demobilization**		$	**250,000**
4	**Well Installation**		$	**2,794,000**
5	**In Well Treatment System**		$	**1,517,000**
6	**Vapor Transmission Pipe**		$	**1,294,000**
7	**Centralized Vapor Treatment System**		$	**211,000**
8	**Treatment Plant Building**		$	**420,000**
9	**Reporting and Site Management**		$	**175,000**
	Sub-Total			**$8,138,000**
	Contingency	25%	$	**2,035,000**
	Sub-Total		$	**10,173,000**
	Project Management		$	**150,000**
	Remedial Design		$	**250,000**
	Permitting		$	**100,000**
	Construction Management		$	**50,000**
	Construction Oversight		$	**125,000**
	TOTAL CAPITAL COST		$	10,848,000

ANNUAL O&M COST:

Item No.	Description	Quantity		Total
Years 1-5				
1	**Operation**		$	**424,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**178,000**
	Sub-Total		$	**666,000**
	Contingency	10%	$	**67,000**
	Sub-Total		$	**733,000**
	TOTAL ANNUAL O&M COSTS		$	733,000

Table 5-14 Updated Cost Estimate for Alternative 8A

Alternative 8A
IN-WELL VAPOR STRIPPING

COST ESTIMATE SUMMARY

Site: NCIA
Location: North Hempstead, NY
Phase: Feasibility Study (-30% - +50%)
Base Year: 2013
Date: February 15, 2013

Description: Alternative 8A consists of full plume remediation of the upper and deep portions of the off-site groundwater contaminant plume by implementing in-well vapor stripping and centralized off-gas treatment.

Item No.	Description	Quantity		Total
Years 6 - 30				
1	**Operation**		$	**424,000**
2	**Maintenance**		$	**10,000**
3	**Performance Monitoring**		$	**54,000**
4	**Monitoring and Institutional Controls**		$	**90,000**
	Sub-Total		$	**578,000**
	Contingency	10%	$	**58,000**
	Sub-Total		$	**636,000**
	TOTAL ANNUAL O&M COSTS		$	636,000

PERIODIC COSTS:

Item No.	Description	Year		Total
1	**Carbon Profiling**	1	$	**950**
2	**Long Term Maintenance & Five Year Review**	5	$	**65,000**
3	**System Decommissioning**	30	$	**1,636,500**

PRESENT VALUE ANALYSIS: Rate of Return: 7% Interest Rate: 3%

Item No.	Cost Type	Year	Total Cost		Present Value
1	**Capital Cost**	0		$	**10,848,000**
2	**Total Annual O&M Cost**				
	2.1 Year 1 - 5	1-5	$ 732,550	$	**3,272,000**
	2.2 Year 6 - 30	6-30	$ 635,775	$	**8,311,000**
3	**Periodic Costs**			$	**713,000**
	TOTAL PRESENT VALUE OF ALTERNATIVE			$	23,144,000

Appendix A

Original FS Layouts for Alternatives 4A&B – 7A&B

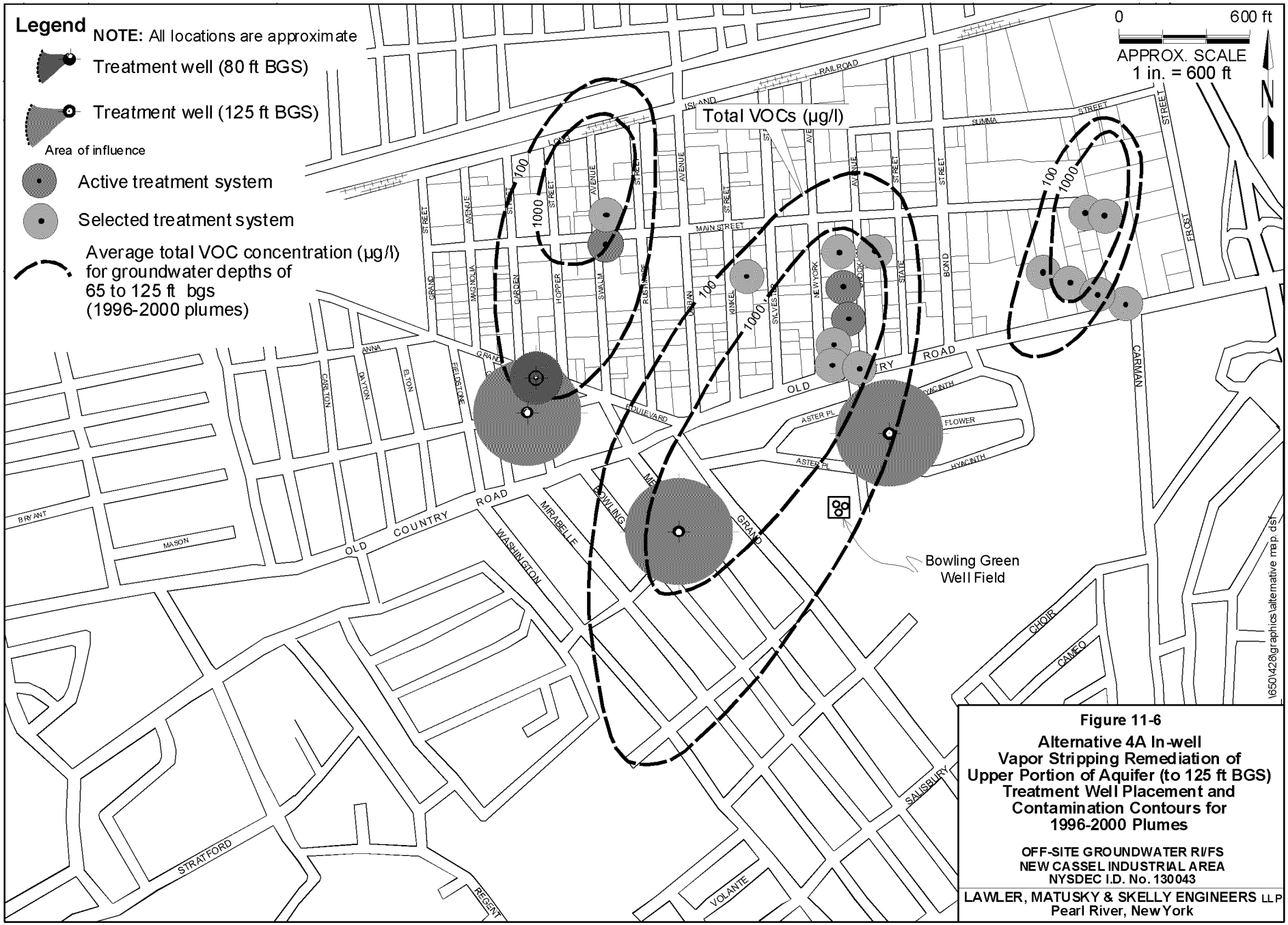

Figure 11-6

Alternative 4A In-well Vapor Stripping Remediation of Upper Portion of Aquifer (to 125 ft BGS) Treatment Well Placement and Contamination Contours for 1996-2000 Plumes

OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
NYSDEC I.D. No. 130043

LAWLER, MATUSKY & SKELLY ENGINEERS LLP
Pearl River, New York

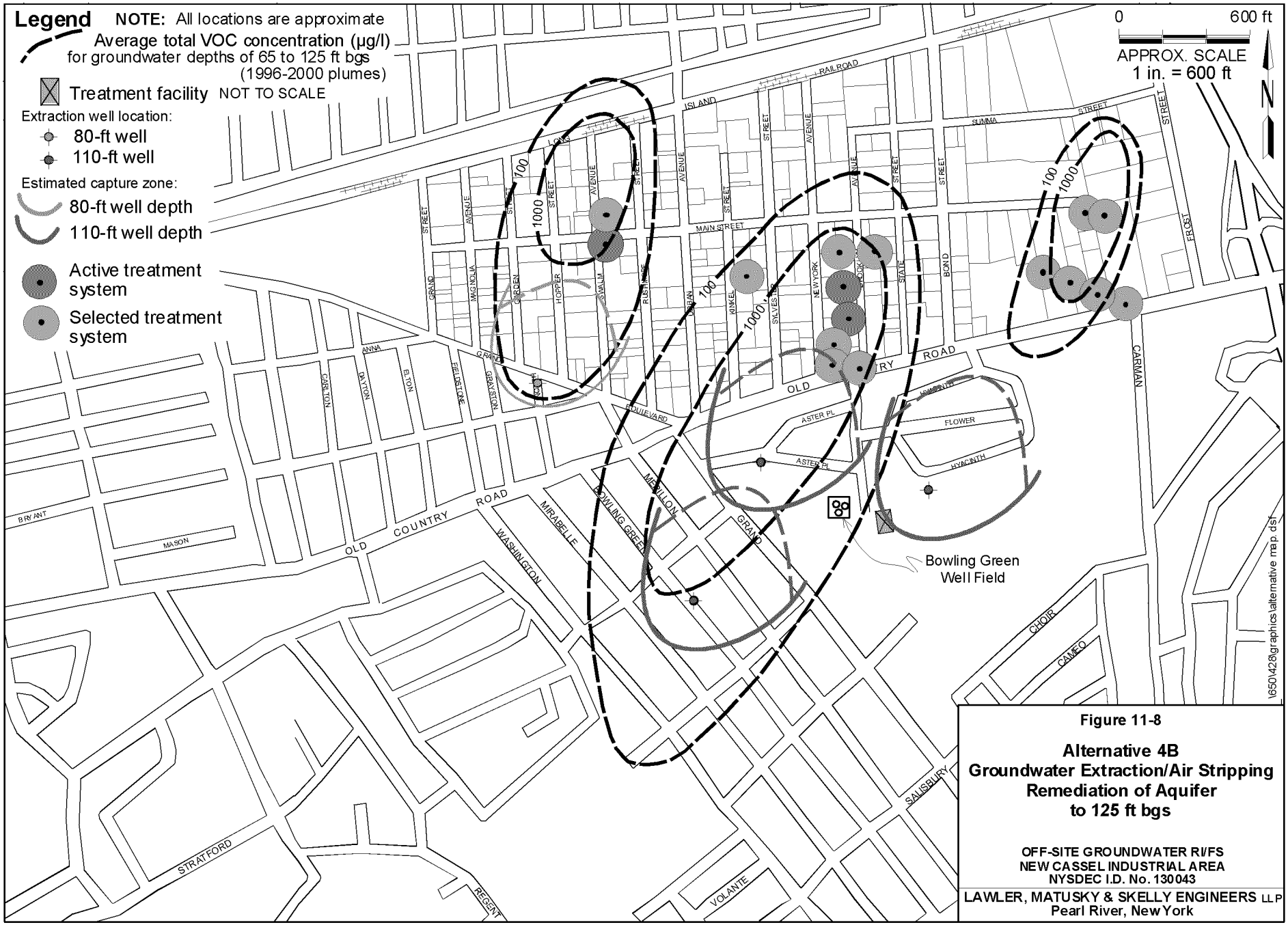

Figure 11-8

Alternative 4B
Groundwater Extraction/Air Stripping
Remediation of Aquifer
to 125 ft bgs

OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
NYSDEC I.D. No. 130043

LAWLER, MATUSKY & SKELLY ENGINEERS LLP
Pearl River, New York

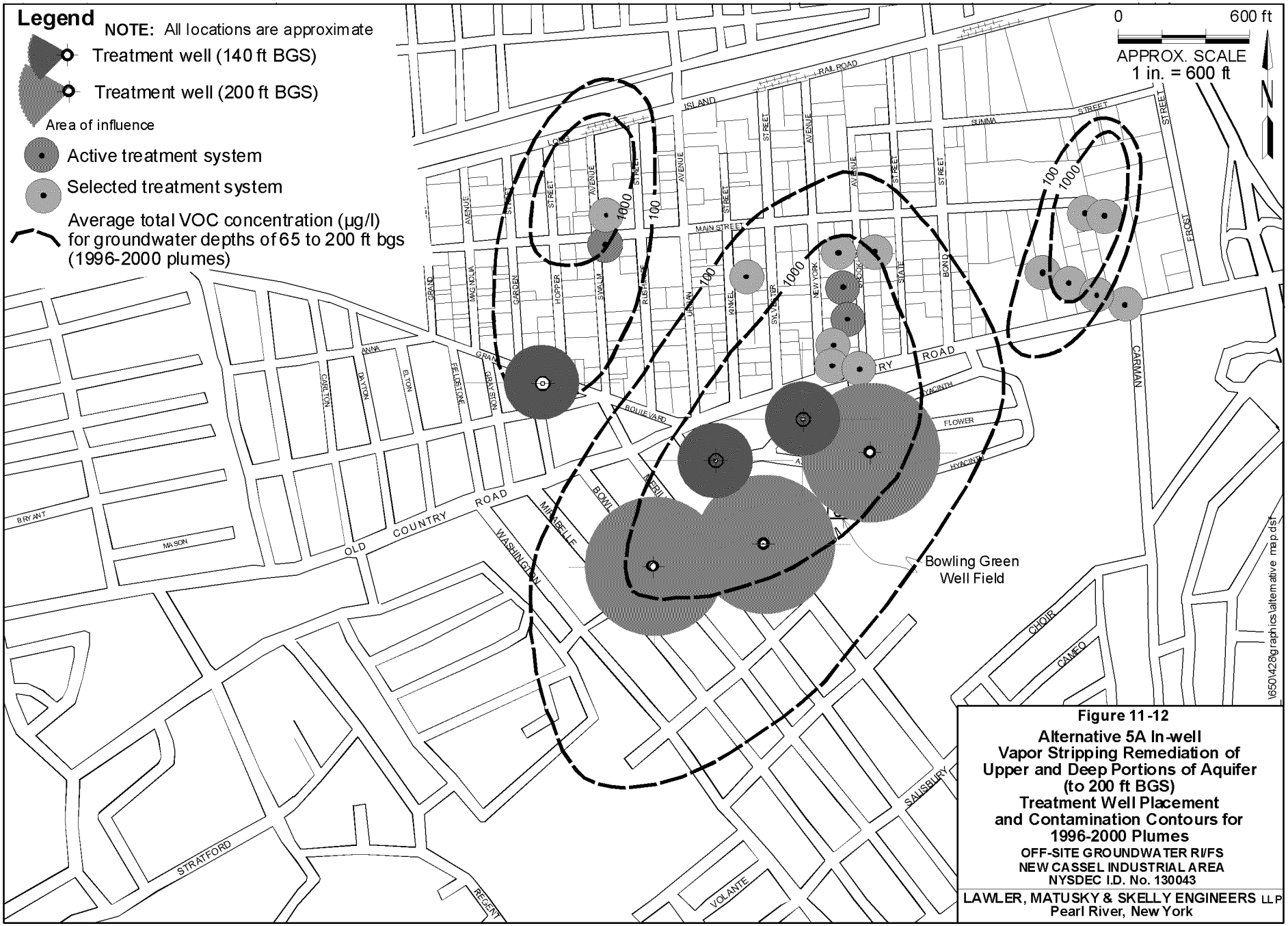

Figure 11-12
Alternative 5A In-well Vapor Stripping Remediation of Upper and Deep Portions of Aquifer (to 200 ft BGS) Treatment Well Placement and Contamination Contours for 1996-2000 Plumes
OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
NYSDEC I.D. No. 130043

LAWLER, MATUSKY & SKELLY ENGINEERS LLP
Pearl River, New York

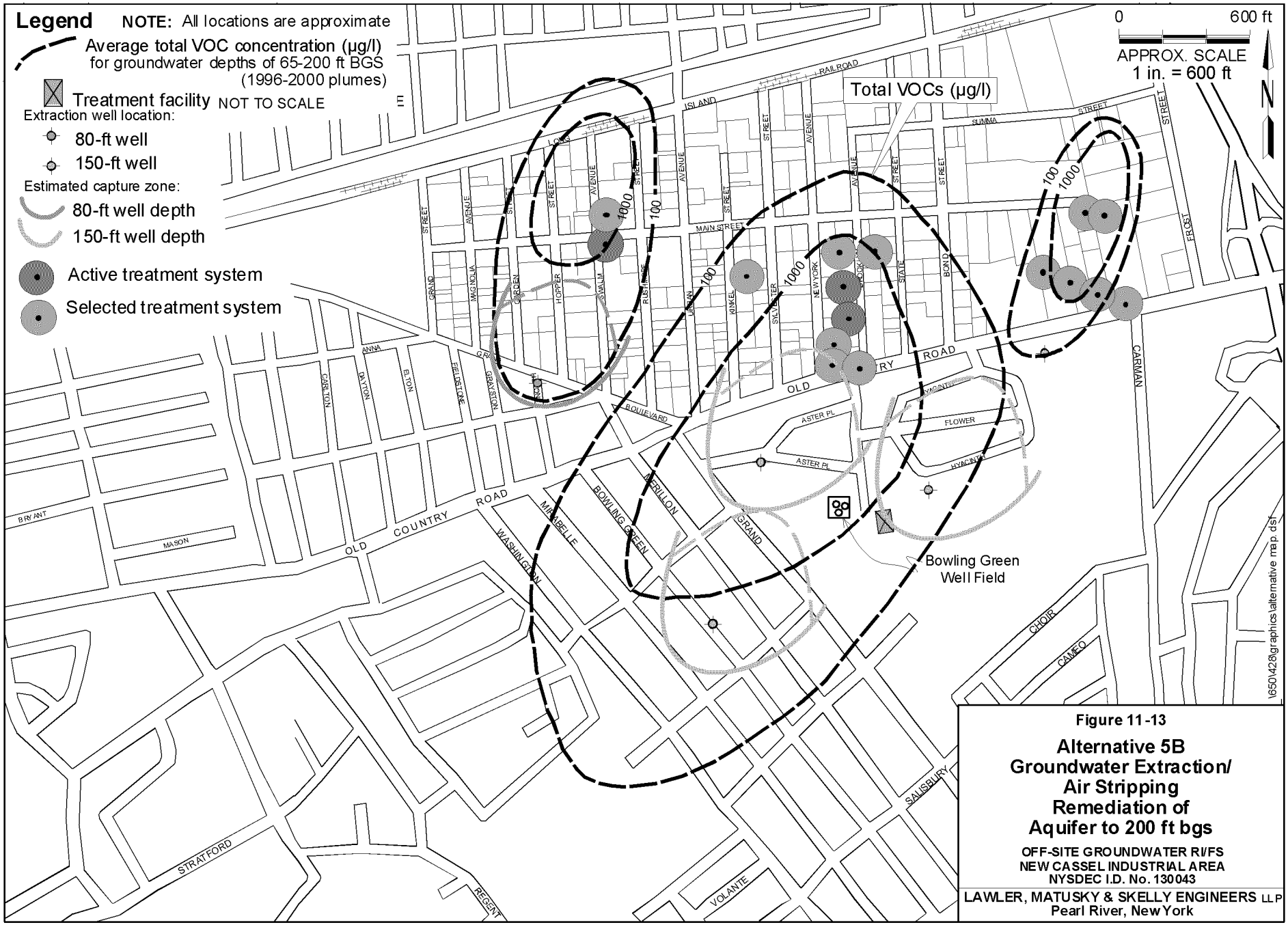

Figure 11-13

Alternative 5B
Groundwater Extraction/
Air Stripping
Remediation of
Aquifer to 200 ft bgs

OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
NYSDEC I.D. No. 130043

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Pearl River, New York

Figure 11-14

Alternative 6A
In-Well Vapor Stripping
Full Plume Remediation of Upper Portion of Aquifer
(to 125 ft BGS)

OFF-SITE GROUNDWATER R/FS
NEW CASSEL INDUSTRIAL AREA
NYSDEC I.D. No. 130043

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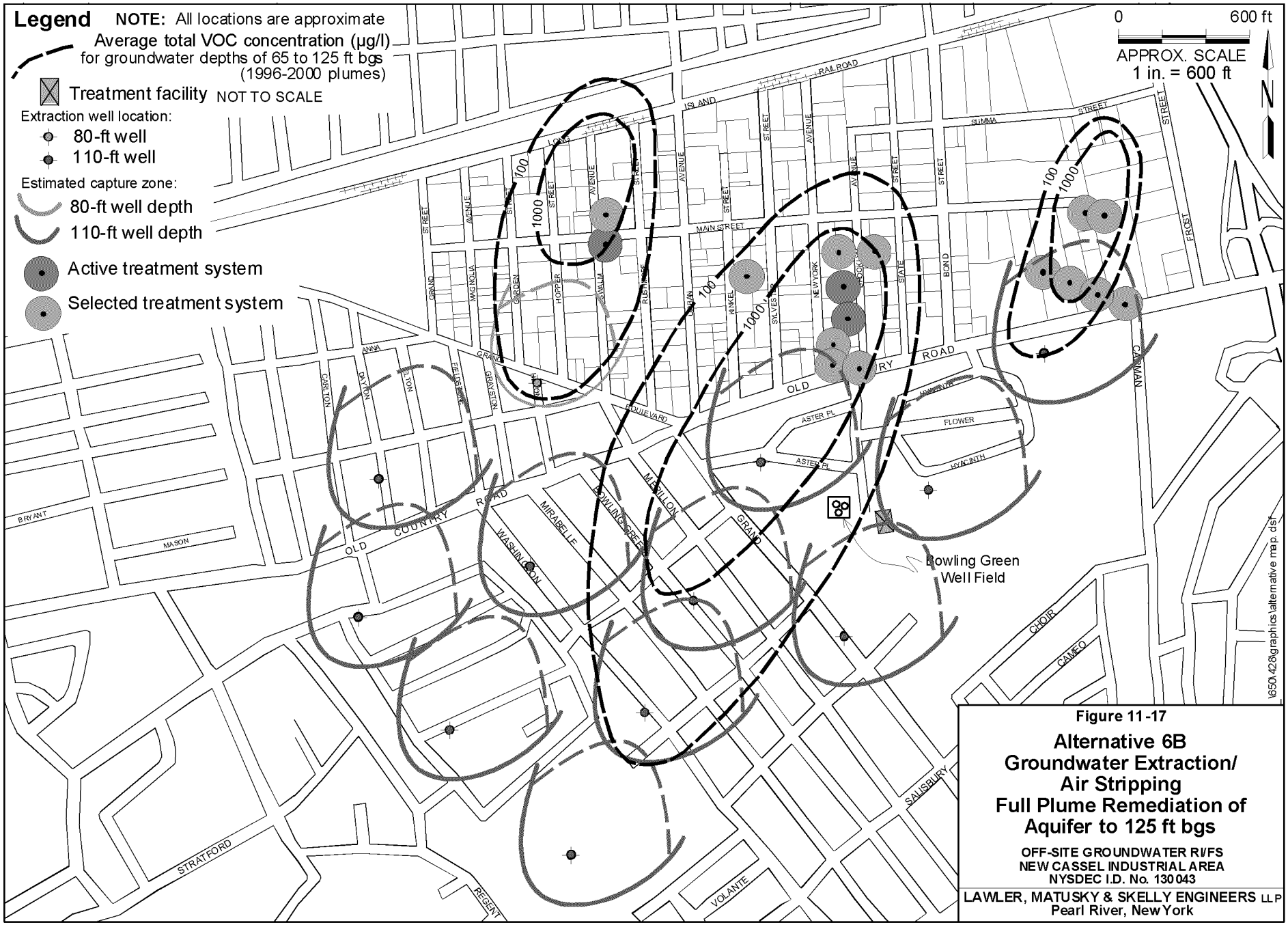

Figure 11-17

Alternative 6B
Groundwater Extraction/ Air Stripping
Full Plume Remediation of Aquifer to 125 ft bgs

OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
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Figure 11-20
Alternative 7A
In-well Vapor Stripping Full Plume Remediation of Upper and Deep Portions of Aquifer (to 200 ft BGS) Treatment Well Placement and Contamination Contours for 1996-2000 Plumes
OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
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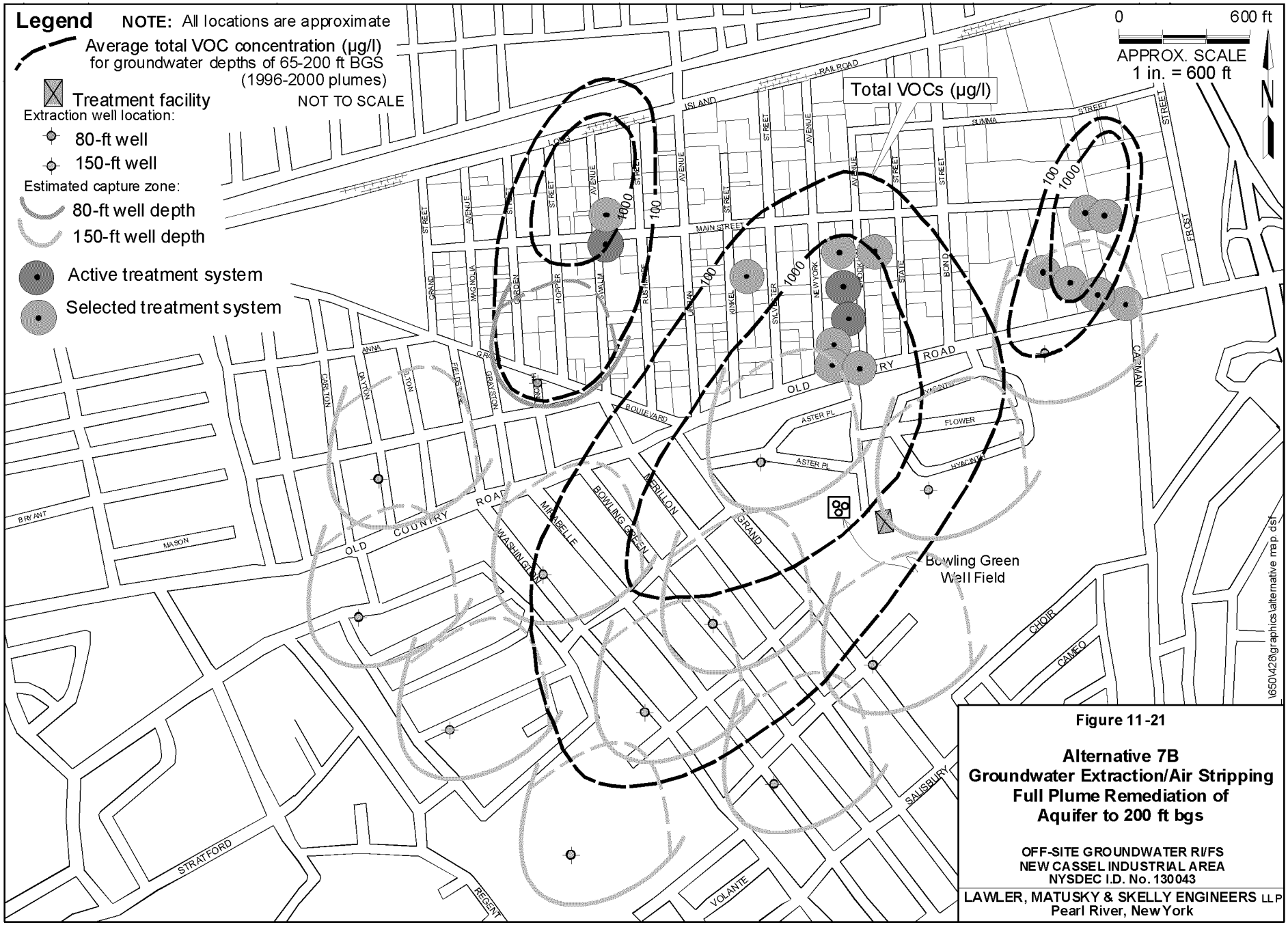

Figure 11-21

Alternative 7B
Groundwater Extraction/Air Stripping
Full Plume Remediation of
Aquifer to 200 ft bgs

OFF-SITE GROUNDWATER RI/FS
NEW CASSEL INDUSTRIAL AREA
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